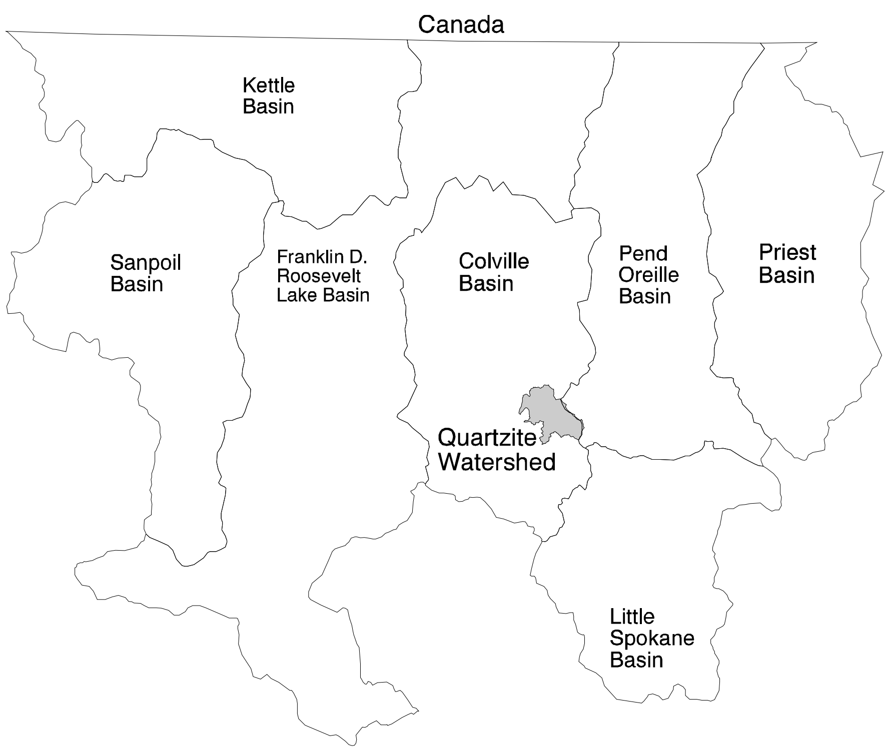
USFS

Colville National Forest

Quartzite

Watershed Scale Ecosystem Analysis

Ecosystem Analysis Report



December 1998

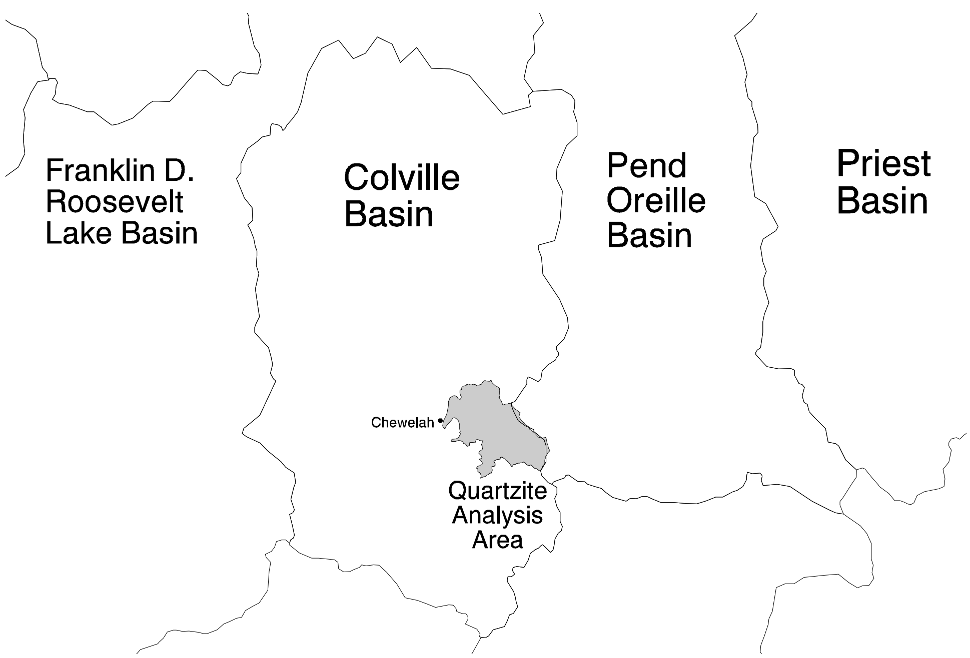
Chapter

1

Characterization

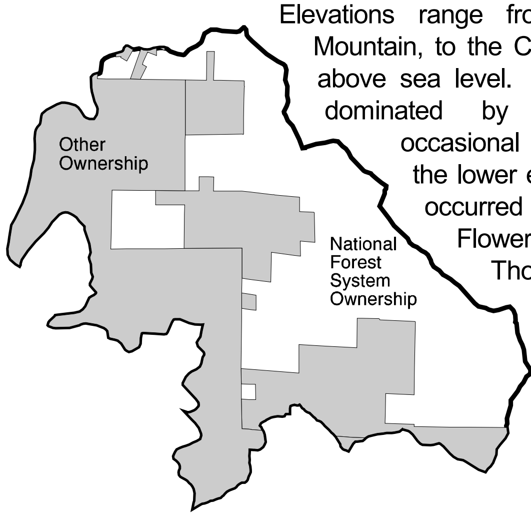
This is the first of five chapters that document the Quartzite Ecosystem Analysis. In this chapter, the dominant features and ecological processes of the watershed are highlighted. **Chapter 2** identifies the issues and key questions that focus analysis. **Chapter 3** describes current and reference conditions in terms relevant to core topics and issues. **Chapter 4** explains changes between current and reference conditions and their probable causes. **Chapter 5** describes recommendations for management activities that are responsive to the issues.

The Quartzite analysis area is located on the southeast side of the Colville River Basin, directly east of the town of Chewelah, Washington. It occupies a relatively small percentage (3.6%) of this larger basin and is limited to three small west-flowing streams (Thomason, Sherwood & Cottonwood) that drain into the Colville River.



Thirty six miles downstream from the analysis area, the Colville River empties into the Franklin D. Roosevelt Reservoir, the pool formed by the Columbia River Grand Coulee Dam.

The analysis area is 36.4 square miles in size, 55% of which is private or other ownership. Elevations range from the 5,700 foot Chewelah Mountain, to the Colville River, which is 1,640 feet above sea level. Vegetation in the watershed is dominated by coniferous forest, however occasional pastures and fields are found at the lower elevations. Fire suppression has occurred for the past 80 years. The Flowery Trail Road passes through the Thomason Creek Drainage, in the northern third of the analysis area. It provides access to the adjacent downhill ski area, for an estimated 50,000 visitors per year.



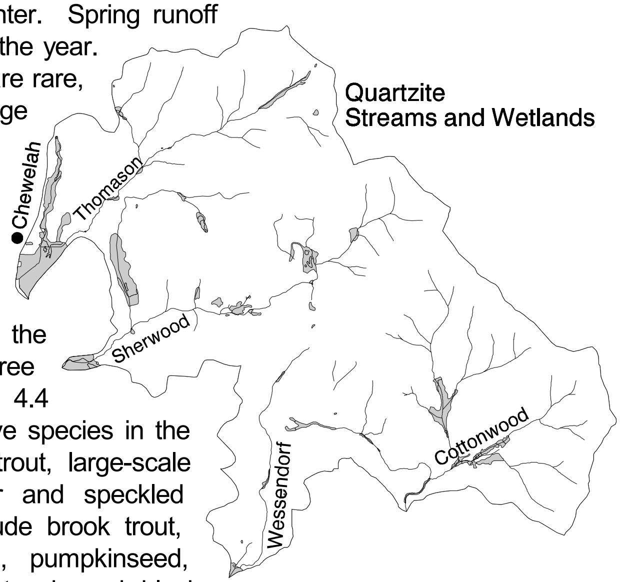
Section 1.1 - Distinguishing Physical, Biological and Human Features

The geologic history of the Quartzite watershed began with the deposition of sedimentary rock in a shallow water environment over 600 million years ago. During the Cretaceous Period (100 million years ago), the North American plate began moving west and as the sinking Pacific plate melted, split and domed deep beneath the Quartzite area, the parent sedimentary rock was intruded by igneous rock. Additional deformation of the parent rock occurred up until 2 million years ago, and includes the broad folding and faulting that formed many of the mountainous landforms present today. These landforms have been modified over the eons by glacial events, the most recent of which occurred 14,000 years ago. The glacial ice during this event was at least 4,000 feet thick in the Colville River Valley, which means only the summit of Chewelah Mountain was above the massive sheet. As the glacier receded and melted, small moraines, and outwash terraces and plains were left behind. Other landform modifications have occurred since then and are represented by alluvial fans, talus slopes, stream channels, wetlands and lakes.

Eight major soil series occupy the analysis area (Aits, Huckleberry, Donavan, Raisio, Rock Outcrops, Bonner, Newbell & Buhrig). Most share the attributes of being well-drained soils formed in glacial outwash or till, with a mantle of volcanic ash. While the unconsolidated glacial alluvium that underlies a majority of the soils in the analysis area is susceptible to mass gravity movement when disturbed or under cut, the potential for erosion of surface soils is higher than that for mass movement. The majority of the soils in the analysis area have a high potential to erode from bare slopes, as a result of water action. Vegetation, however is keeping surface erosion at bay and most human-caused erosion originates from roads.

Area weather patterns are influenced by a combination of maritime and continental air masses. The maritime influence from the Pacific Ocean is dominant in the summer, and in the winter, continental air from the north maintains the snowpack. Mild summers and cold winters typify the climate. The average summer temperature at Chewelah is 65°F, with an average daily maximum temperature of 82°. Winter temperatures average 28°, with an average daily minimum of 21°. Annual precipitation increases as elevation increases. Valley amounts on the west side of the area average 19”, while amounts on the ridge to the east average 37”. Most of this falls as snow in the winter, and rain in the spring. Two out of ten summers have less than 6” of rain.

Not suprisingly, the drainages in the area transport a snow-dominated spring runoff from a pack that builds through the winter. Spring runoff provides the main flow event of the year. Mid-winter rain-on-snow events are rare, but they can cause runoff damage from peak flows. More common late spring rain-on-snow events are confined to higher elevations, and peak flows are rarely excessive. A little over 60 miles of streams move water through the analysis area to the Colville River. Of the thirty-three miles that run year-round, only 4.4 miles provide fish habitat. Native species in the Colville River include rainbow trout, large-scale sucker, sculpin, redside shiner and speckled dace. Non-native species include brook trout, brown trout, largemouth bass, pumpkinseed, yellow perch, brown bullhead, tench and black crappie. Because fish habitat in the area is poor, brook trout, which better tolerates degraded habitat, is the dominant fish species. The National Wetland Inventory classifies 853 acres as wetland. Most are located on the Colville River Valley floor, and have been converted for residential or agricultural uses. Other upland wetland areas are associated with low gradient streams and depressions. Many of these have been converted to meadows, to accommodate livestock grazing.

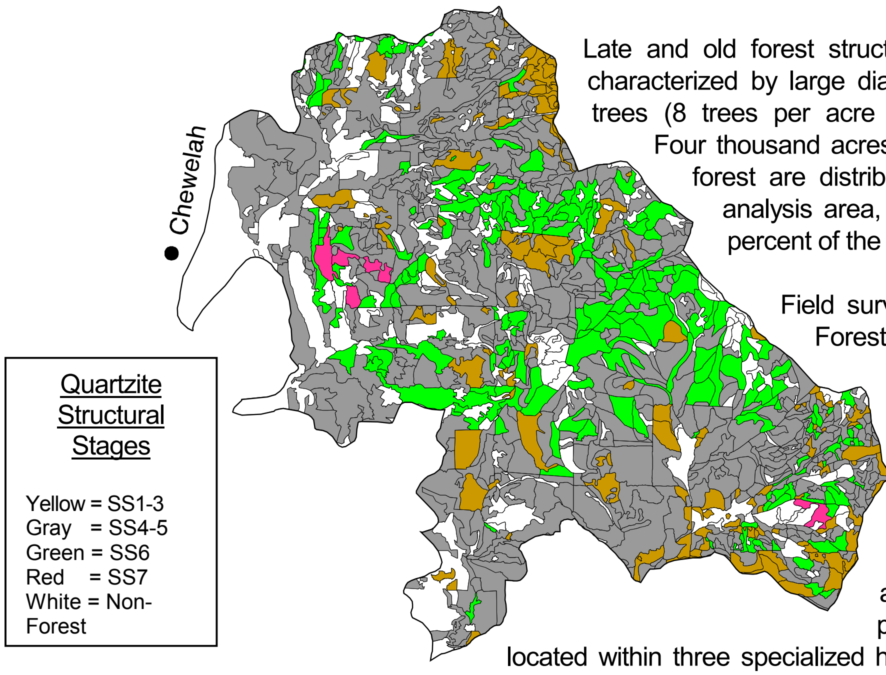


The composition and pattern of vegetation on the landscape are dynamic. However, large-scale fire events have been absent for over 60 years. Today, eighty percent of the area under analysis is forested. Other areas include agricultural lands, residential sites, roads, rock and water. Within forested areas, ownership defines two general situations. Forests located on the steeper less accessible National Forest System Lands tend to be overstocked (compared to reference conditions) and include larger diameter trees. Forests elsewhere have typically seen some type of logging over the past 30 years; consequently they contain fewer, smaller diameter trees.

Upland forests not associated with riparian areas can roughly be divided into two environments: south-facing slopes and north-facing slopes. South-facing slopes contain mixed conifers characteristic of the drier Douglas-fir plant associations, with ponderosa pine serving as the dominant seral species. On many of these south facing sites, thickets of Douglas-fir grow beneath large diameter ponderosa pine, Douglas-fir and western larch. The remnants of trees damaged by storms, insects and disease contribute to the 10-25 tons per acre of fire-fuels found in most stands. Cool, moist Douglas-fir plant associations dominate north-facing slopes, with grand fir and western redcedar plant associations common in moist and protected areas. Fire-fuels trend toward larger diameter (> 3”) pieces and range from 15-35 tons per acre.

Riparian forests are confined to the relatively narrow areas influenced by streams and wetlands. Western red cedar and grand fir create a dense conifer tree canopy here, with black cottonwood, birch and aspen scattered throughout lower gradient riparian areas.

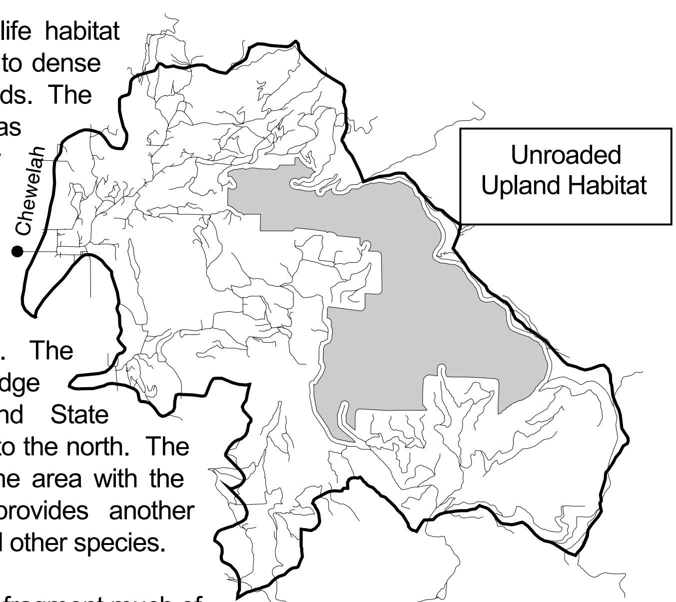
Due to their high productivity, these stands often carry heavy fire-fuel loads; up to 50 tons per acre in some areas.



Late and old forest structural stages are characterized by large diameter overstory trees (8 trees per acre > 21”diameter). Four thousand acres of late and old forest are distributed across the analysis area, representing 17 percent of the total area.

Field surveys of National Forest System Lands yielded 20 populations of those plants recognized by the National Forest System as sensitive plants. All were located within three specialized habitats: forested riparian habitat; wetland/wet or dry meadows/pond habitats; and open forest and rocky outcrop habitat. Populations appear to be stable or slightly increasing, with the exception of those associated with open forest, which have declined.

Noxious weeds are species that have been introduced into North America from European, Asian, and Mediterranean countries. These species have little or no natural competition or controlling agents on this continent. Seven noxious weed species have invaded the area. Most are shade intolerant and opportunistic when soil is exposed. Problem populations are located along roads, and trails, near mines and in fields and logging areas.



The area has a variety of wildlife habitat types, ranging from high ridges to dense forests to cleared agricultural lands. The ridges and valley floor serve as travel corridors for many species. The ridge on the east boundary runs north to the Canadian border and provides a travel corridor for many species, which may include grizzly bear, gray wolf and lynx. The Flowery Trail road crosses this ridge within the analysis area and State Highway 20 crosses it 20 miles to the north. The Colville River valley connects the area with the Columbia River valley, and provides another travel corridor for many birds and other species.

Roads, fields and logging areas, fragment much of the habitat. Road density across the Quartzite Analysis Area averages 3.84 miles per square mile. The road density on National Forest System Lands is 2.01 m/m^2. An isolated block of unroaded upland forest habitat, roughly 5,000 acres in size is located on National Forest System Lands on the east side of the area.

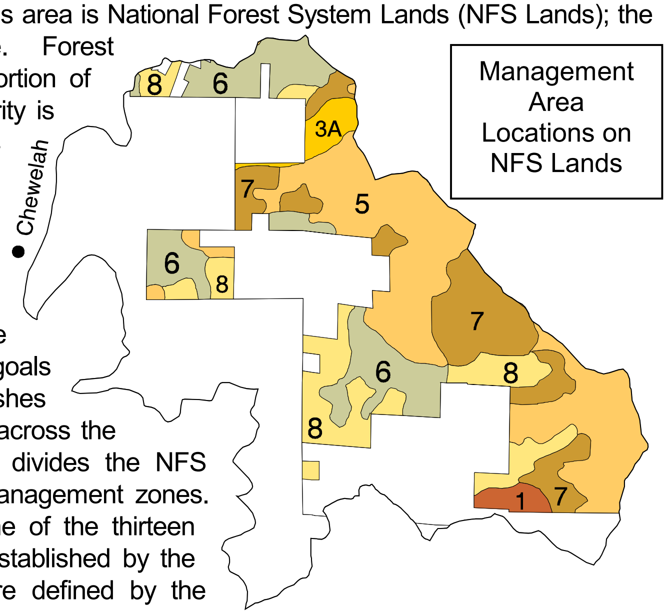
Wildlife species using the area include mule deer, whitetail deer, elk, moose, beaver, cougar, porcupine, chipmunk, black bear, bats, skunk, muskrat, coyote, bobcat, raccoon, ermine, squirrels, shrews, voles, mice, snowshoe hare, thrushes, sparrows, flycatchers, chickadees, wrens, woodpeckers, hawks, turkey vulture, swallows, hummingbirds, owls, Stellar's jay, crow, raven, juncos, warblers, waterfowl, salamanders, western skink, frogs, trouts, western painted turtle and snakes. For others, the habitat is available but they have not been seen in the area.

Humans use the area for both recreation and subsistence. There are approximately 140 miles of roads in the area. Year-round recreation activities include: firewood gathering, berry picking, snowmobiling, cross-country-skiing, bicycling, hiking, camping, off-road vehicle riding, horseback riding, and hunting. The forests in the northeast corner of Washington State are recognized as prime white-tailed deer habitat. Hunters from throughout the region travel here during the fall big-game hunt. During this time, most dispersed camping sites within the Quartzite area are occupied. Local residents value the unique features of the west side of Quartzite Mountain that faces the town of Chewelah. The vertical rock cliffs provide an aesthetic backdrop for the town as you approach from both the north and the south.

The town of Chewelah has been portrayed as an isolated trade center where employment is dependent on agriculture and timber. Other employment includes tourism and mining. The resources in the Quartzite Analysis Area contribute to all of these. As noted above, roughly 50,000 annual skiers pass through the area in route to the adjacent downhill ski area. Numerous fields and pastures and rangeland located on the west side of the area provide agricultural income. And an estimated 130 million board feet of merchantable timber is standing on 13,000 acres within the analysis area, 6,000 of these acres are on National Forest System Lands.

Section 1.2 - Land Allocations and Management Plans

Forty five percent of the analysis area is National Forest System Lands (NFS Lands); the remainder is State or private. Forest products companies hold a portion of the private land, but the majority is smaller woodlands, ranches and residences.



The Colville National Forest adopted a Land and Resource Management Plan (Forest Plan) in 1988. The strategy adopted to meet the goals of the Forest Plan establishes zones, or management areas across the Forest. This zoning strategy divides the NFS Lands into a patch-work of management zones. Each zone is classified as one of the thirteen different management areas established by the Plan. Management Areas are defined by the

Forest Plan as units of land to which a prescription or set of prescriptions is applied in order to achieve a particular management objective. These objectives differentiate the thirteen management areas. The management area prescriptions define the type and intensity of resource activities that are or are not permitted. The Forest Plan zoning effort produced five different management areas within the Quartzite Analysis Area.

Mgt. Area Emphasis	Management Area Goal	Acres	% of NFS Lands in Analysis Area
MA-1: Old Growth Dependent Species Habitat	Provide essential habitat for wildlife species that require old growth forest components, and contribute to the maintenance of diversity of wildlife habitats and plant communities.	217	2%
MA-3A: Recreation	Provide roaded and unroaded recreation opportunities in a natural appearing setting.	311	3%
MA-5: Scenic/Timber	Provide a natural appearing foreground, middle, and background along major scenic travel routes while providing wood products.	3,975	37%
MA-6: Scenic/Winter Range	Provide a natural appearing foreground, middle and background along major scenic travel routes while providing for winter range management.	2,082	20%
MA-7: Wood/Forage	Manage to achieve optimum production of timber products while protecting basic resources.	2,130	20%
MA-8: Winter Range	Meet the habitat needs of deer and elk to sustain carrying capacity at 120% of the 1980 level, while managing timber and other resources consistent with fish and wildlife management objectives.	1,872	18%
	TOTAL =	10,587	100

The Colville subbasin (and consequently the Quartzite analysis area) is within the boundary of the area analyzed by the Integrated Scientific Assessment for Ecosystem Management in the Interior Columbia Basin. This assessment divided the Columbia Basin into six subbasin clusters of forestland that have common ecological conditions. The Quartzite Analysis Area is located in Forest Cluster 6. Using coarse analytical procedures, the Scientific Assessment assigned ecological integrity ratings to each cluster, where a high rating indicates ecological functions and processes are being maintained. Forest Cluster 6 was rated “low” for aquatic, hydrologic, forest and composite ecological integrity, due to: declines in late and early forest structure; fragmented aquatic systems; roads; and the cropland conversion of lower elevation valleys. The Scientific Assessment also identified the social and economic conditions of the communities in the Columbia Basin. As noted above, Chewelah was identified as an isolated trade center, with employment specialized in agriculture and wood product manufacturing.

Chapter
2

Issues and Key Questions

Issues identify the resource concerns or problems that are unique or relevant to the ecological system associated with the Quartzite Analysis Area. Their relevance is determined by their relationship to ecosystem resilience (The ability of an ecological system to maintain its functions in the face of change or disturbance.).

The Key Questions associated with each issue focus the analysis on elements that can be measured at the watershed scale. The Issues and Key Questions are organized into two main areas - *Stream Corridors and Wetlands,* and *Upland Vegetation.*

Section 2.1 - Stream Corridors and Wetlands Issue

In the last 100 years, the vegetation in many low gradient, low elevation riparian areas has been converted from forested wetland to pastures or fields. Along other low elevation streams logging has removed most large high value trees. In the past, these diverse forested riparian corridors extended from the Colville Valley bottom up into the analysis area, and linked the rich valley with upland forests, wetland areas and streams.

Key Questions

1) What are the dominant erosion processes in the area? How do they compare to reference processes? What role does riparian vegetation play in erosion processes?

2) What is the current condition of riparian vegetation? How does this compare to reference conditions? What are the causes of change between current and reference conditions?

3) What are the current conditions of stream channel types and sediment transport and deposition processes in the area? How do they compare to reference conditions? How does riparian vegetation affect stream channel types and sediment transport and deposition processes?

4) How do wildlife species use riparian corridors? What vegetation conditions are important? How does the current condition compare to reference conditions? How have changes in riparian condition affected dependent species?

Section 2.2 - Upland Vegetation Issue

Prior to this century, wildfire served an integral ecological function in the analysis area. The past 60 years of fire suppression has removed this function from the ecological system. In response, upland vegetation has changed, as has its interactions with other ecosystem components.

Key Questions

1) What biophysical environmental settings are present in this analysis area? How do their current conditions compare to reference conditions? How have upland structural conditions changed from reference conditions?

2) How have changes in species composition, forest density and forest structure changed the resiliency of the landscape to fires, insects and diseases? How has fire suppression affected the character and arrangement of upland stands?

3) How do changes in species composition, forest density and forest structure affect wildlife habitat? Has habitat diversity changed relative to reference conditions? How has fire suppression affected species dependent on old forest-single story structure? How have changes in species composition, forest density and forest structure affected species dependent on old forest multi-story structure?

Chapter
3

Current and Reference Conditions

This chapter displays information about analysis area conditions for five broad ecosystem elements - *Erosion Processes, Hydrology, Vegetation, Species & Habitats, and Human Uses.* Issues and Key Questions developed in Chapter 2 serve to focus the analysis of these conditions.

Both current conditions and reference conditions are displayed to highlight changes in ecosystem conditions over time. Reference conditions are not static. They represent a range of landscape patterns and conditions that result from those disturbance regimes characteristic of the current major climatic period. Reference conditions include human influence, but are limited to the influence of indigenous people.

Section 3.1 - Erosion Processes

What are the current conditions and trends of the dominant erosion processes prevalent in the analysis area? What are the reference erosion processes within the watershed? Where have they occurred? What role does riparian vegetation play in erosion processes?

Geology

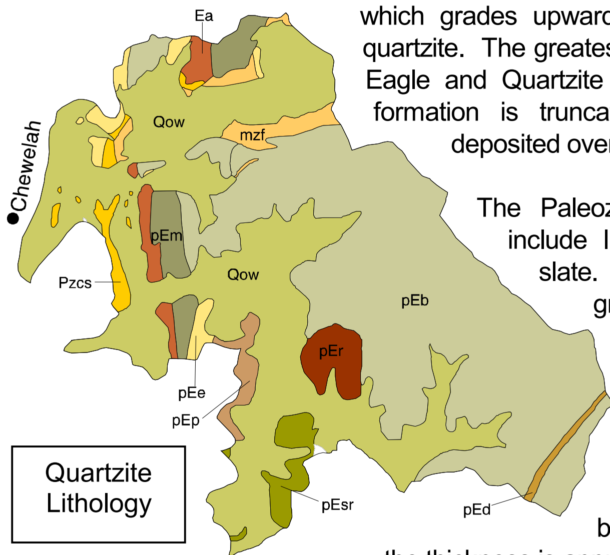
The analysis area is underlain by folded, faulted and regionally metamorphosed sedimentary and volcanic rocks of the Precambrian era (>600million years ago); folded and faulted Cambrian quartzite carbonate rocks of the Paleozoic era (230 - 600 million years ago); and intermediate plutonic rocks of the Mesozoic era (63 – 230 million years ago).

Precambrian rocks include the belt series, which is more than 8,000 feet thick. Argillite rock is 500 to 1500 feet thick alternating with units of inter-bedded quartzite. The argillite is well-stratified light green or dark gray to light gray in color. The quartzite is fine grained and contains 2 to 20% sericitic materials. White is the most common color, however light green and gray are common in the argillaceous quartzite.

Deer Trail rocks underlay the southern half of the analysis area and members include the Edna dolomite, consisting of dolomite, argillite, phyllite, and quartzite. The dolomite is finely laminated and impure. The argillite is undistinguishable from that of the belt series. The quartzite is glassy, coarse grained and thickly bedded. It is deformed and metamorphosed to a calc-silicite rock and schist. The thickness of this series is estimated between 1500 to 2000 feet.

The McHale slate member is uniform and consists of almost entirely dark gray and green argillite interspersed with beds of quartzite and siltstone, less than one inch thick. Many of these outcrops have a striped appearance.

The only Cambrian rocks in the analysis area are those of the Addy quartzite. It is medium to coarse-grained white or pink glassy orthoquartzite, commonly crossbedded in appearance. At the base of this formation is approximately 150 feet of black-striped purple which grades upwards through pink and on into white quartzite. The greatest exposed thickness is 1600 feet on Eagle and Quartzite Mountains. At both locations the formation is truncated by faults. The quartzite is deposited over the McHale slate.



Quartzite Lithology

The Paleozoic rocks are carbonates, which include limestone, dolomite and a maroon slate. Most are a grayish, medium to fine grained and medium to thickly bedded except near contacts with intrusive rocks where they are coarse, crystalline, massive and mostly white. East of Chewelah the rock is sheared, brecciated and re-cemented. Between the faults that bound both sides of the carbonates the thickness is approximately 2,000 feet.

The Quaternary deposits (0 – 500 thousand years ago) include alluvial and glacial deposits. The alluvial deposits are confined to the immediate vicinity of present-day streams. The most abundant are sand and gravel in outwash plains, terraces and in-mantle deposits on hillsides.

Fine grained lake deposits underlie parts of the Colville River Valley and an area between the carbonate rocks and the Addy Quartzite. Glacial ice covered the western half of the analysis area with a separate lobe extending into Burnt valley. Small moraines occur in the area north of Burnt valley. In other valleys glacial outwash was transported eastward.

Structure

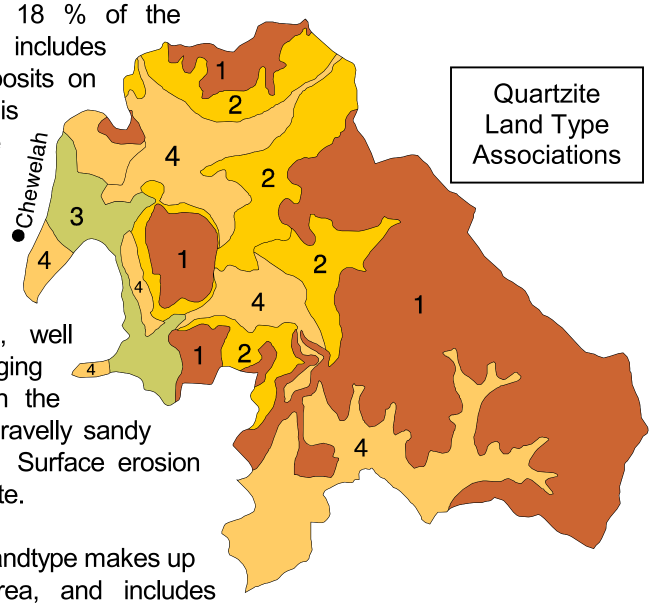
The complicated structure present in the analysis area, results from successive deformations ranging in age from the Precambrian era to the Cenozoic era (0 – 63 million years ago). Broad open folding and faulting occurred prior to the deposition of the Addy Quartzite. The west side of the area is faulted with normal faults forming natural stream corridors or weakness zones in the bedrock. The oldest faults in the analysis area are those that are trending north. The majority of the area is composed of argillite and quartzite with limestone and dolomite of the belt series.

Landtype Associations

There are four landtypes in the analysis area.

1) **<u>Continentally glaciated steep mountain slopes and ridges (>40% slope)</u>**. This land type makes up 48% of the analysis area, and includes steep mountain slopes, peaks and ridges. Slope gradient ranges from 40 to 90 percent. Slopes are generally convex in both the vertical and horizontal planes. Local relief is high with stream bottom to ridge distances varying from 300 to 800 feet. Soils are well drained with textures ranging from loam to silt loam in the upper 18 inches to very gravelly sandy loam down to 60 inches. Surface erosion potential is moderate to very severe. The parent materials associated with this landtype, that exhibit geologic faulting and landforms with parallel drainage patterns, tend to be prone to mass wasting.

2) **<u>Continentally and alpine glaciated moderate mountain slopes (<40% slope)</u>**. This landtype makes up 18 % of the analysis area, and includes extensive till and drift deposits on lower slopes. It is characterized by moderate to low mountain slopes, peaks and ridges that are generally convex to flat both in the vertical and horizontal planes. Soil tends to be very deep, well drained with textures ranging from loam to silt loam in the upper 18 inches to very gravelly sandy loam down to 60 inches. Surface erosion potential is slight to moderate.



3) **<u>Low scoured hills.</u>** This landtype makes up 6 % of the analysis area, and includes exposed bedrock with glacial valley fill in a complex of kames, terraces and low hills. Flat to low hilly slopes of residual bedrock generally convex in both vertical and horizontal planes. Soils are deep, well drained with textures ranging from loam to gravelly sandy loam in upper horizons to cobbly sandy loam and very gravelly coarse sandy loam up to 10 to 14 inches deep. Surface erosion potential is slight to moderate depending on the slope.

4) **<u>Glaciofluvial or lacustrian terraces and alluvial deposits</u>**. Located in the lower elevation bottomlands. Flat to gently rolling topography which is slightly convex both in the vertical and horizontal planes. Parent material is glacial/alluvial materials or stratified lacustrine deposits of local origin. Soils are very deep, somewhat poor draining, with textures ranging form silt loam to silty clay loam in the upper 10 inches, with silt clay for the next 15 to 20 inches. Surface erosion potential is dependent on slope. This landtype makes up 28 % of the analysis area.

Mass Wasting and Slope Stability

The analysis area contains three situations of concern for mass wasting and slope stability. The argillite/quartzite rock forms steep slopes, much of which is covered in talus. These steep talus slopes are unstable, especially at the toe of the slope and lower mid slope sections. Vegetation rarely covers these rocky areas. A second area of concern occurs where a micaceous silt about 30 feet thick follows the thrust fault on Chewelah Mountain. This area is susceptible to a mass gravity movement due to the effects of mechanical weathering. The third area of concern is a glacial legacy. Glacial till and glacial outwash deposits are composed of well-rounded rock, with fragments ranging in size from fine sand up to boulders. These deposits are generally unconsolidated and are susceptible to slope failure when disturbed or undercut.

While these three situations are susceptible to mass gravity movement when disturbed or under cut, the potential for erosion of surface soils is higher than that for mass movement. Areas where soil erosion potential is highest are located in glacial outwash, till and alluvial deposits along streams, where sandy, silty and gravely soils exist.

Soils

As noted in Chapter 1, eight major soil series occupy 80% of the analysis area (Aits, Huckleberry, Donavan, Raisio, Rock Outcrop, Bonner, Newbell & Buhrig).

1) **Aits Series** (22%) The Aits soil series is a stony loam, which covers approximately 5200 acres. These are deep, well drained soils formed in glacial till with a mantle of volcanic ash and loess. The taxonomic class is a coarse-loamy, mixed, frigid Andic Xerochrepts. It is well drained, with slow to very rapid runoff and moderately slow permeability. Aits soils are located on glaciated foot hills and mountain slopes at elevations of 2,000 to 5,000 feet. Slopes range from 0 to 65 percent. The volcanic ash and loess mantle ranges from 7 to 14 inches thick. Soils contain from 5 to 35 percent rock fragments. They are slightly acid or neutral throughout.

2) **Huckleberry Series** (15%) The Huckleberry series covers approximately 3500 acres. It consists of moderately deep, well-drained soils that formed in colluvium and residuum from phyllite, shale, and quartzite with a mantle of loess and volcanic ash. These soils are located on mountainsides and ridge tops at elevations of about 3,000 to 6,000 feet, on slopes of 0 to 70 percent. The taxonomic class is ashy over loamy-skeletal, mixed Typic Vitricryands. The volcanic ash mantle is 14 to 22 inches thick. Depth to parent rock is 20 to 40 inches. The representative soil is silt loam or loam modified by 35 to 60 percent coarse fragments. The silty mantle overlies residuum and colluvium weathered from phyllite, shale, and quartzite. These soils are well drained, with medium to very rapid runoff and moderate permeability.

3) **Donavan Series** (13%) The Donavan soil series covers approximately 3000 acres. Soils in this series are well drained soils, formed in mixed glacial till with a component of loess and volcanic ash in the upper profile. They are located on toe-slopes, foot-slopes, and back-slopes of foothills and mountains that range from 0 to 65 percent at elevations of 1,800 to 4,000 feet. The taxonomic class is a coarse-loamy, mixed, mesic Vitrandic Haploxerolls. Rock fragments average from 10 to 35 percent and clay averages from 5 to 15 percent of the representative soil. These soils are well drained, with slow to very rapid runoff and moderate permeability.

4) **Raisio Series** (12%) The Rasio series is a shaly loam covering approximately 2900 acres of the analysis area. It consists of moderately deep, well drained soils formed in residuum and colluvium from shaly rocks modified in places by glacial till and volcanic ash. Raisio soils are on generally south-facing footslopes, sideslopes and ridgetops of mountains, where slopes range from 0 to 65 percent. The taxonomic class is a loamy-skeletal, mixed, mesic Vitrandic Haploxerolls. The depth to bedrock is 20 to 40 inches. The representative soil has 35 to 80 percent shaly fragments and flagstones. It is slightly acid to neutral. These soils formed in residuum and colluvium from shaly rock (argillite, phyllite, slate and shale), modified in places by glacial till, volcanic ash and loess. They are well drained with medium to very rapid runoff and moderate permeability.

5) **Rock Outcrops** (7%) Rock outcrops cover roughly 1630 acres within the analysis area.

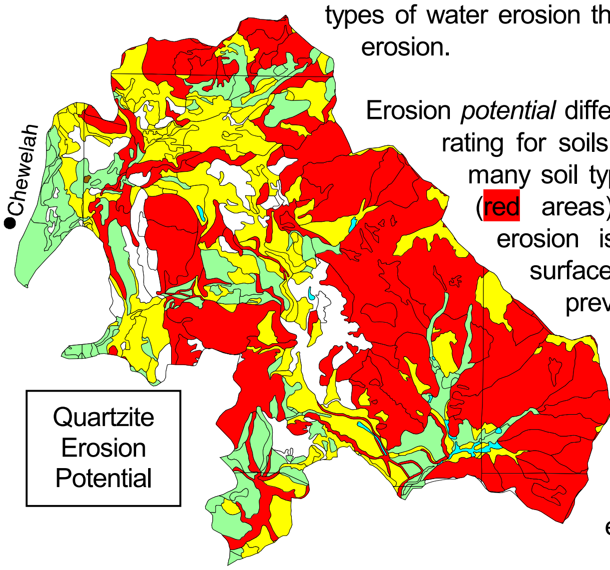
6) **Bonner Series** (5%) The Bonner gravely silt loam series covers approximately 1200 acres. It consists of very deep, well-drained soils formed in glacial outwash material derived dominantly from granite, gneiss and schist, with a mantle of volcanic ash and loess. These soils are on terraces and terrace escarpments, ranging from 2,000 to 3,200 feet elevation. Permeability is moderate in the solum and rapid to very rapid in the underlying material. Slopes range from 0 to 65 percent. The taxonomic class is ashy over sandy or sandy-skeletal, mixed, frigid Typic Vitrixerands. These soils are well drained. Runoff is slow on the terraces and ranges from medium to rapid on the escarpments.

7) **Newbell Series** (4%) This soil series is silt loam and covers approximately 900 acres. It consists of deep, well-drained soils formed in glacial till with a thin mantle of volcanic ash and loess. These soils are on toeslopes, footslopes, and backslopes of mountains, rangeing from 2,100 to 4,500 feet elevation on slopes of 0 to 65 percent. The taxonomic class is loamy-skeletal, mixed, frigid Andic Xerochrepts. It is a well-drained soil with slow to very rapid runoff and moderate permeability. Rock fragments average 45 percent of the representative soil.

8) **Buhrig Series** (2%) The Buhrig soil series is a very stony loam that covers approximately 500 acres of the analysis area. It consists of moderately deep, well drained soil formed in residuum and colluvium from igneous and metasedimentary rocks with a mantle of volcanic ash and loess. These soils are on mountain ridges and knobs at elevations of 3,000 to 6,500 feet, where slopes range from 20 to 65 percent. This series is a loamy-skeletal, mixed Andic Cryochrepts. Depth to bedrock ranges from 20 to 40 inches. Thickness of the volcanic ash is 7 to 14 inches. The representative soil has 50 to 90 percent acid igneous and metasedimentary rock fragments. More than half are cobble, flags and stones. The soil is neutral to moderately acid throughout.

Erosion Processes

Erosion potential refers to the susceptibility of a soil surface to erode from *bare slopes* as a result of water action. Bare soil areas include fields, log yarding trails, and roadways. The types of water erosion that can occur are sheet, rill, and gully erosion.



Erosion *potential* differs by soil type. The erosion potential rating for soils within the analysis area shows that many soil types have a high potential for erosion (red areas). Within these areas, extensive erosion is expected to occur on bare soil surfaces and widespread erosion cannot be prevented unless soil disturbing activities are avoided or mitigated.

Other areas show a moderate potential for erosion (yellow areas). In these areas, extensive erosion can occasionally occur where soil is exposed, but it can be reduced or limited by careful logging and by avoiding unnecessary surface disturbance. The remaining soils are rated with low erosion potential or are not rated.

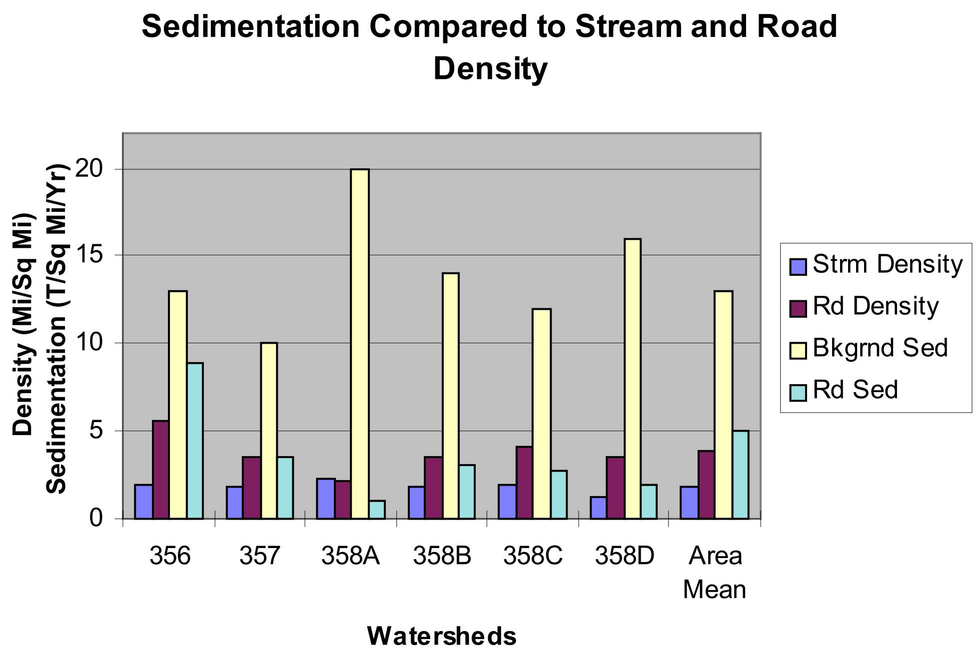
Surface erosion occurs when detachable soils on sufficiently steep slopes are exposed to overland flow and/or the impact of rainfall. Sediments introduced to streams from surface erosion processes are generally fine-grained and can influence water quality and aquatic habitat. Hillslope angle, soil texture (especially cohesiveness), and climatic factors all influence the inherent erosion hazard of a site. These natural factors can be aggravated by forestry and agricultural activities that accelerate soil detachment and transport. Such activities as cultivation, road construction, tractor yarding, and burning or piling for site preparation can expose bare mineral soil and compact and/or intercept subsurface flows and encourage overland flows. Signs of unacceptable levels of stream channel sedimentation include scouring (degradation), lateral bank cutting, bar building and filling of pools.

The primary erosion processes under current climatic conditions within the analysis area are stream channel erosion, and sheet and rill erosion from roads.

Stream banks composed of unconsolidated sand and gravel in glacial deposits, terraces, and modern floodplains appear to be the main source of sediment delivered to streams. Present bank erosion is generally small in scale although widespread. There are very few locations where lateral channel migration has occurred. Where livestock are concentrated in riparian areas, their affect on bank erosion has been severe. Because sand is a major component in stream banks, sand is present in the channel substrates of most streams. In areas of low stream gradients, sand is a dominant component of the surface of the channel bed. In higher-gradient reaches, sand collects in the lee of boulders, and the spaces between boulders and cobbles. Most stream channel segments in the watershed are capable of transporting sediment delivered by bank erosion.

Fine sediment from surface erosion from slopes exposed at harvest is a minor source and is limited to a few areas of recent harvest with little or no delivery to streams. Current forest practices that require buffering along streams (in conjunction with low impact yarding practices) have helped to minimize soil disturbance and transport of sediment to streams. Permeable soils and low stream densities in these watersheds also contribute to a lack of surface runoff and sediment delivery to streams.

Roads within these watersheds are also eroding and contributing sediment to streams, primarily at stream crossings. However, the number of stream crossings is low in relation to the total road mileage within the watershed. Sheet erosion and rill erosion are the primary erosion processes affecting the travel surface of these roads as well as on cut and fill slopes. Aggregate or paved surfacing helps in mitigating these problems as does the presence of cut and fill slope vegetation. Current and recent past log haul traffic-use patterns in the watershed have been low. In general, road sediments are not a problem to streams except in localized areas.



While the background sediment levels average 13-tons/square mile/year across the analysis area, there are differences between the subwatersheds. Variations in background levels range from a low of 10-tons/mi^2/yr in the Thomason Creek sub-watershed (#357), to a high of 20-tons/mi^2/yr in the Betts subwatershed. The high background levels of sediment in the Betts sub-watershed (#358A) are attributed to its high stream density, which increases its potential to deliver sediment.

Sediment delivery from roads does not follow the same pattern as the background estimates. Thomason Creek with the highest road density also has the highest contribution of sediment from roads. The Betts subwatershed with the highest background sediment rate, has the lowest delivery attributed to roads due to its low road density.

The primary source of sediment entering stream channels is from natural background levels. Bank erosion occurs where obstructions such as woody debris divert flows against banks and causes lateral shifting and sedimentation. The greatest sediment delivery occurs in the smaller perennial and larger intermittent streams located on glacial alluvium. The channels of these streams are relatively stable, but the peak flows they convey are capable of eroding banks and beds. The magnitude of these events occurs on a small scale and is not likely to change dominant channel characteristics or processes. Larger perennial streams occupy channels formed during glacial periods of higher flows. Current peak flows in these channels do not reach the magnitudes that originally formed them and are consequently quite stable. The small intermittent and ephemeral streams carry surface water only during spring runoff, and even then, the magnitude of flow appears to be small and incapable of providing significant erosion potential or sediment delivery.

The second most important source of sediment in these watersheds is from roads. There are numerous roads within the analysis area, which cross or are located adjacent to streams. The potential for erosion and sediment delivery to these streams is directly proportional to the distance between the roads and the streams. Roads located within

200-300 feet of streams may serve as a direct supply of sediment from their travel surfaces, as well as their cut-banks, fill-slopes, and ditches. The Flowery Trail Granodiorite is a relatively non-resistant and easily weatherable formation, which has the potential to increase sediment loads in streams.

Reference Erosion Processes

As noted at the beginning of this chapter, reference conditions are not static. They represent a range of landscape patterns and conditions that result from those disturbance regimes characteristic of the current major climatic period. Reference disturbance regimes include human influence, but are limited to the influence of indigenous people. Reference disturbances included fire (primary), weather-related events (wind/ice storms and rain-on-snow), and insects and disease.

Reference fire intervals vary widely across the area. As a result, the quantity of down and dead material, snags, and in-stream large woody debris has varied over space and time. Where fire was absent for abnormal periods, insect and disease processes affected vegetation. These reference disturbance processes produced a mosaic of age classes and species along riparian zones. Disturbance events have ensured the availability and cycling of large woody material through the streams, causing channel adjustments, and trapping sediment behind debris jams. These processes take decades or centuries to complete their work and conditions today are directly related to the response of existing vegetation to these influences.

Historically, sediment was delivered to streams from landslides that occurred along the margins of terraces: from stream down-cutting and lateral movement (especially through glacial terraces) and from surface erosion after fire (sediment delivery increased dramatically after such fires). Removal of the litter layers by fire increased sheet, rill, and gully erosion. Subsequent decomposition of roots from trees killed by the fires also destabilized slopes until seral vegetation became established. These processes were always part of the natural disturbance regime and played a crucial and beneficial role in flushing and rebuilding channels. These natural disturbances occurred at varying levels of intensity, but were separated by relatively long periods of recovery time. Human activities over the last 90 years (logging, farming, ranching, and road construction/maintenance) have presented new disturbance events. These new events differ from reference events, in that they provide chronic frequent sediment delivery, from smaller areas over shorter time spans.

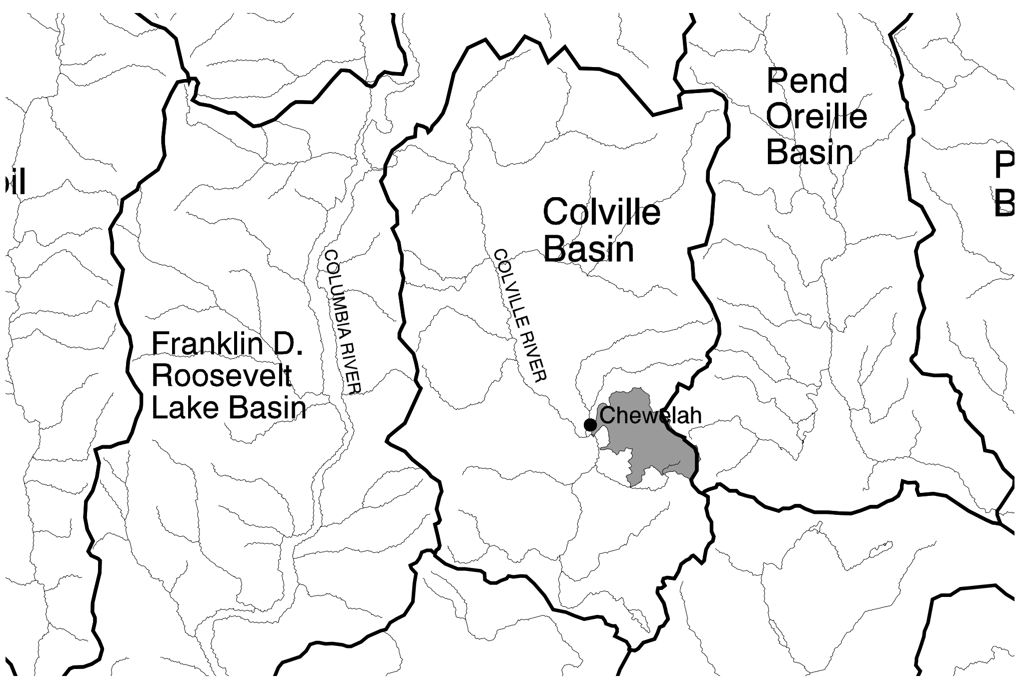
Reference beaver activity occurred along low gradient stream in the analysis area. Distribution was dependent on habitat conditions and predator-prey relationships. The Colville River Valley served as the source for beaver populations moving into adjacent tributary watersheds from the main valley. Aspen and other preferred food of the beaver were enhanced by fire. Beaver ponds serve as depositional traps for sediment moving through the system. These ponds also intercept and store water on its journey through the hydrologic cycle. Unless maintained, these dams eventually disintegrate allowing defined streams channels to again develop and down-cut through previously deposited sediments. Current beaver activity is restricted to Woodward and Betts Meadows, in the south end of the analysis area.

Section 3.2 - Hydrology

What are the current conditions and trends of the dominant hydrologic characteristics and features prevalent in the analysis area? What are the current conditions and trends of stream channel types, and sediment transport and deposition processes prevalent in the watershed? What are the current conditions and trends of beneficial uses and associated water quality parameters? What are the reference hydrologic characteristics in the analysis area? What were the reference morphological characteristics of stream valleys and the general sediment transport and deposition processes in the analysis area? What were the reference water-quality characteristics of the analysis area? How does riparian vegetation affect stream channel types and sediment transport and deposition processes?

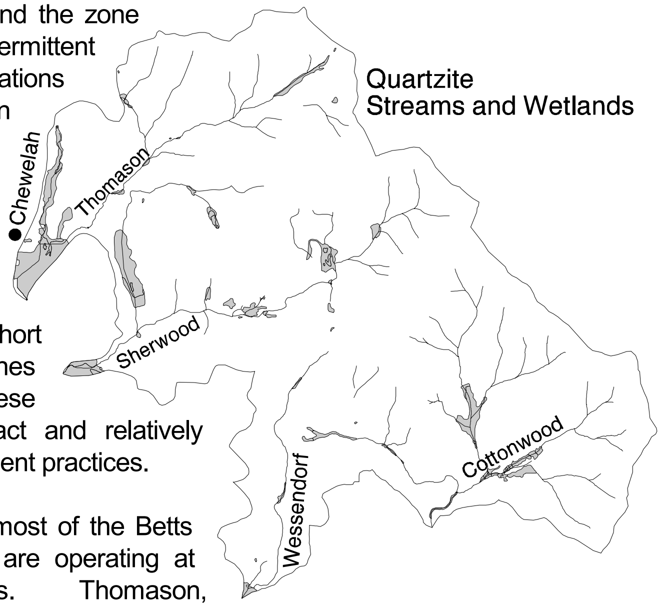
The Colville River is one of the smaller tributaries to the Columbia River. It originates in southern Stevens County and flows north for φ50 miles before emptying into the Columbia River, just south of Kettle Falls, Washington. The Colville drains a 1,007 square mile area, which represents 0.39% of the Columbia River Basin. Measurements taken from 1924-1979 show the Colville River had an average discharge of 302 cubic feet per second, compared to 179,800 cf/s for the Columbia.

The Quartzite Analysis Area (36 mi.^{2}) occupies 3.6% of the Colville River Basin and is composed of three small west-flowing streams (Thomason, Sherwood & Cottonwood) that drain into the Colville River.

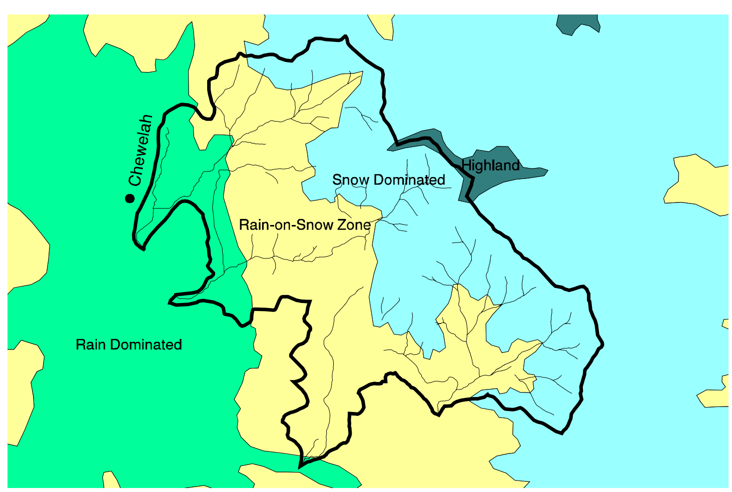


Stream Channel

The streams and associated riparian systems within the analysis area continue to react to the influences of catastrophic fires, logging, agricultural/grazing practices and ongoing residential development. The moist characteristics of some riparian zones on National Forest System lands, left them unaffected by fires. Lower gradient streams and associated riparian zones are generally wider due to geology, soils, and valley geomorphology. As stream channels extend higher into the watersheds, flows decrease along with channel widths and the zone of riparian influence. Intermittent streams at the upper elevations have very narrow riparian corridors, in some cases extending only a few feet on either side of the channel. Consequently, abrupt changes from riparian to upland vegetation may be encountered over short distances. The riparian zones in the upper portions of these sub-watersheds remain intact and relatively unaffected by past management practices.



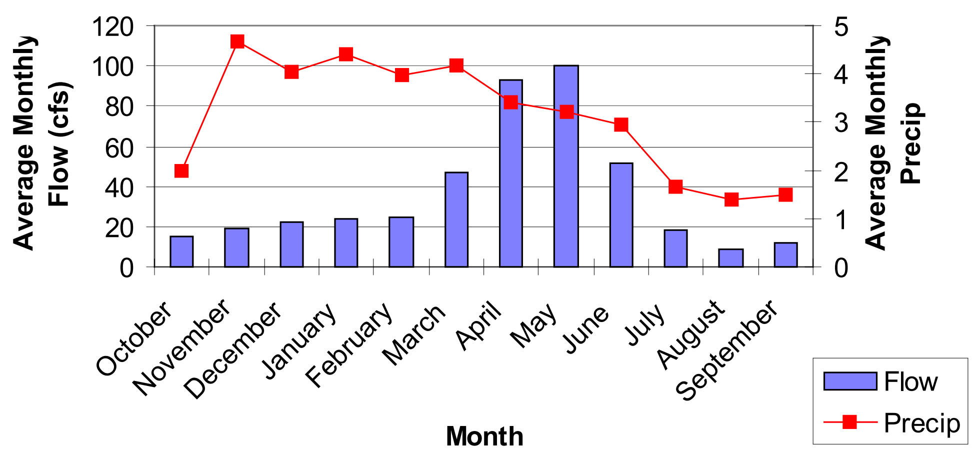
The headwater streams of most of the Betts and Sherwood watersheds are operating at near reference conditions. Thomason, Wessendorf, and Woodward, while more affected by management activities are still in a properly functioning condition, **on NFS Lands**. Streams and wetlands in this condition include attributes (landform, adequate vegetation, and large woody debris) that act to dissipate excess stream energy associated with high flows. These attributes also filter sediment, capture bedload, aid floodplain development, and improve flood-water retention and ground-water recharge. Root masses armor stream-banks against cutting action and large wood debris helps develop pools and channel characteristics that provide the water depth, duration, and temperature necessary for fish production and waterfowl breeding.



As noted in Chapter 1, the streams in the analysis area have a snow-dominated runoff regime, fed by a snowpack that remains throughout the winter. Spring runoff is the main flow event of the year. Mid-winter rain-on-snow events are rare, but can cause runoff damage from peak flows. Late spring rain-on-snow events of either rain or warm air are more common but they are confined to the higher elevations and peak flows are localized and usually do not exceed bank width.

The nearest USGS streamflow-gauging station was maintained from 1958-1974 on Chewelah Creek, located just north of the analysis area. Data from this station shows the relationship between the average monthly precipitation and the average daily streamflow. Also evident is the delay in water release from the winter months when precipitation is highest, to the spring, when streamflow peaks.

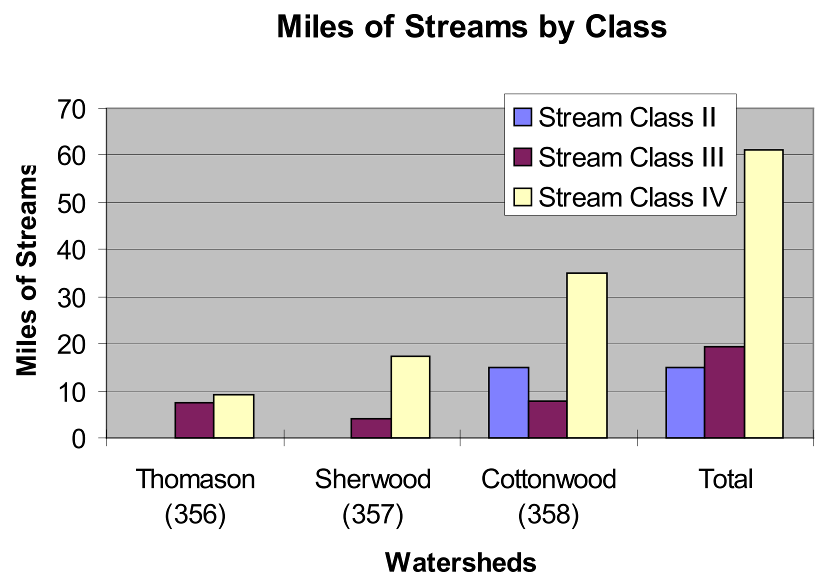
Average Monthly Streamflows for Chewelah Creek for Water Years 1958-1974 and Average Monthly Precip from Chewelah Peak 1979-1996



Slopes in the upper portions of watersheds within the analysis area are steep, and runoff and sediment delivery are efficient; however, the area is buffered by glacial and valley features that act to moderate peak flows.

Annual peak flows can occur from January to May. The data shows the peak most often occurs during the month of May (7 years out of 17 years). Anomalies, however do occur. A flood event on January 24th, 1974 recorded a peak flow of 392 cf/s. Most often, peak flows result from snowmelt, or snowmelt accompanied by rainfall and Chinook winds. Major flooding along Chewelah Creek occurs on an average of 15-20 years. From the turn of the century seven major flood events have occurred: 1904, 1927, 1953, 1956, 1960, 1974, and 1997.

Stream classes for the three Quartzite sub-watersheds are displayed below. This graph includes the entire Cottonwood Watershed (21,340 acres), not just the portion within the Quartzite Analysis Area (10,466 acres). Class II streams are perennial, fish bearing streams; Class III streams are perennial, non-fish bearing; and Class IV streams are intermittent. Class IV streams comprise the majority of all streams in the analysis area and only the Cottonwood Watershed has fisheries within NFS Lands.



Thomason sub-watershed current condition

Area	5376 acres (8.4 mi^2)
Land-ownership	34.6% National Forest System (NFS) lands, 65.4% non-NFS Lands.
Elevation	Elevations range from 1640' at the mouth of Thomason Creek to 5123' on Jay Gould Ridge
Average Slope	22%
Aspect	West
Channel Type	1.1 miles of channels were surveyed within the watershed on NFS land. Most streams are Rosgen type A or Aa+. Channel substrate is sand/silt (Rosgen 5/6). Perennial Channels: 0.7 miles are Class 3, with an additional 0.3 miles classified as alternating between Class 3 and 4. Intermittent/Ephemeral Channels: 0.1 miles are Class 4, with an additional 4 channels classified as ephemeral with no length determined. Channel types and condition are unknown on non-NFS Lands.
Drainage pattern	Dendritic. This pattern is characterized by irregular branching of tributary streams in many directions and at almost any angle, although usually at considerably less than a right angle. They develop upon rock of uniform resistance and imply a notable lack of structural control.
Drainage Density	Accurate drainage density figures cannot be calculated due to the lack of data for streams on non-NFS land, however stream densities for NFS Lands are 1.98 miles of stream/mi^2.
Relief Ratio	0.1 (Relief Ratio is the quotient of height to length of a basin)
Road Density	Total = 5.55 miles of road/mi^2. Non-NFS land = 6.22 miles of road/mi^2. NFS land = 4.28 miles of road/mi^2.
Gradient	Valley gradients range between 8% and 45%.
Flow Patterns	Peak flows are moderate to low during most years and are moderated by subsurface flow in the glacial valley fill material. Occasional rapid snowmelt events originate from rain or warm winds.

Sherwood sub-watershed current condition

Area	7469 acres (11.7 mi^2)
Land-ownership	34.6% National Forest System (NFS) lands, 65.4% non-NFS Lands.
Elevation	Elevations range from 1650' at the mouth of Sherwood Creek to 5773' at the summit of Chewelah Peak.
Average Slope	34%
Aspect	West
Channel Type	3.4 miles of channels were surveyed on NFS land. Within the sub-watershed all streams are Rosgen Aa+. Channel substrate are all composed of bedrock or cobble (Rosgen 1/3). Perennial Channels: 0.6 miles are Class 3, with an additional 1.8 miles alternating between Class 3 and 4. Intermittent/Ephemeral Channels: 1.0 mile is Class 4, with an additional 4 channels classified as ephemeral with no length determined. Channel types and condition are unknown on non-NFS Lands.
Drainage pattern	Dendritic. (see Thomason Creek)
Drainage Density	Stream densities for NFS Lands are 1.81 miles of stream/mi^2.
Relief Ratio	0.1
Road Density	Total = 3.48 miles of road/mi^2. Non-NFS land = 4.97 miles of road/mi^2. NFS land = 1.16 miles of road/mi^2.
Graident	Valley gradients range between 25% and 55%.
Flow Patterns	(see Thomason Creek)

Cottonwood sub-watershed current condition

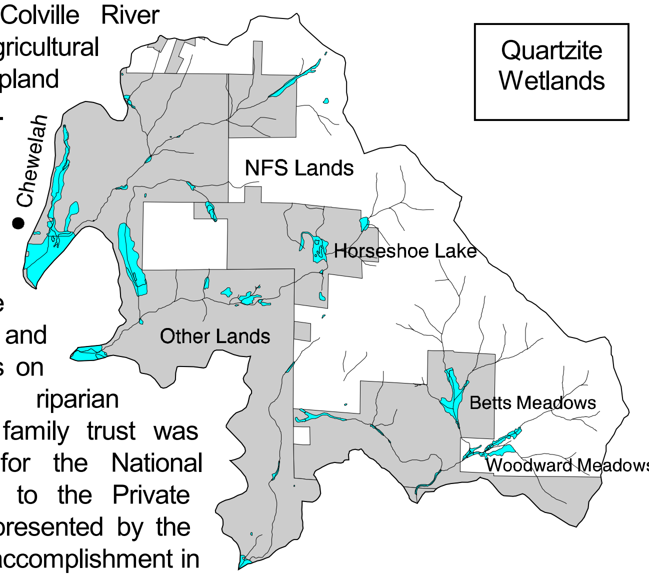
Area	10,466 acres (16.35 mi^2)
Land-ownership	55.4% National Forest System (NFS) lands, 44.6% non-NFS Lands.
Elevation	Elevations range from 1920' at the mouth Wessendorf Canyon to 5400' on the south ridge of Chewelah Peak.
Average Slope	33%
Aspect	West
Channel Type	14.3 miles of channels were surveyed on NFS land. Most streams are Rosgen Aa+. Channel substrate are all composed of cobble or gravel (Rosgen 3/4). Perennial Channels: 8.8 miles = Class 3 with an additional 1.4 miles of Class 2 (fish-bearing). Intermittent Channels = 4.1 miles are classified as Class 4 streams. Channel types and condition are unknown on non-NFS Lands.
Drainage pattern	Dendritic. (see Thomason Creek)
Drainage Density	Stream densities for NFS Lands are 1.84 miles of stream/mi^2.
Relief Ratio	0.1
Road Density	Total = 3.22 miles of road/mi^2. Non-NFS land = 5.19 miles of road/mi^2. NFS land = 1.63 miles of road/mi^2.
Graident	Valley gradients range between 1% and 65%.
Flow Patterns	(see Thomason Creek)

Wetlands

Wetlands serve as a critical moderating component in a watershed's hydrologic budget. The "sponge" effect produced by these areas helps temper both high and low flows. When wetlands are associated with streams, they also exert a strong control on surface water quality. And because of their high moisture content, wetland soils are very sensitive to soil displacement and rutting, and to changes in the groundwater regime.

Approximately 850 acres of wetlands are located within the analysis area, representing 4% of the total area. Roughly 90% of these occur on private lands and are located on the Colville River Valley floor. Only 87 acres are located on NFS Lands, mostly in Woodward Meadows. All wetlands within the analysis area are classified as Palustrine. Palustrine wetlands are dominated by trees, shrubs, and persistent emergents (plant species like cattails, which normally remain standing until the beginning of the next growing season).

Within the analysis area, wetlands frequently occur in glacial outwash, or in beaver meadows at higher elevations. Characteristic of human land use patterns, most low elevation wetlands near the Colville River Valley have been converted to agricultural or residential use. Other upland wetlands have changed less. **Betts Meadows** Wetland Preserve, located on non-NFS Lands in the Cottonwood Creek sub-watershed is a 140-acre family trust. The purpose of the trust is to maintain the property as a wildlife refuge and native fishery, with an emphasis on fostering wetland and riparian environments. In 1994, this family trust was national individual runner-up for the National Wetlands Conservation Award to the Private Sector. This recognition was presented by the U.S. Fish & Wildlife Service for accomplishment in conserving and restoring wetlands to benefit wildlife and other resources. **Horseshoe Lake** is another non-NFS wetland located in the upper reaches of Sherwood Creek, north of Betts Meadows. **Woodward Meadows**, located in a similar setting, just south of Betts Meadows, is the largest wetland located on NFS Lands in this analysis area.



Betts Meadows was originally a swampy, shrub and hardwood/conifer bottomland, which has since been heavily grazed by cattle and sheep for more than eighty years. It had also been farmed with oats, timothy hay, and lettuce. Approximately fifty years ago the meadow was ditched for drainage purposes which lowered the water table sufficiently to allow the soils to dry for cultivation. Aerial photos taken in 1951 show several outbuildings located on the west side of the meadow. Between 1951 and 1994 clearing enlarged the meadow by 25 acres. As part of their restoration process, the Betts Meadows Wetland Preserve constructed a low earthen dam at the southern (outlet) end of the meadow to raise the water table. The overflow structure associated with this dam serves as a barrier to fish passage. This has allowed the introduction of a genetically pure stock of West Slope Cutthroat Trout in association with The Washington State Dept. of Fish and Wildlife. A series of pothole reservoirs were also excavated in the meadow above the dam to provide open water for wildlife.

Prior to 1974, **Horseshoe Lake** in the Sherwood Creek sub-watershed was 20 acres in size. In the spring of 1974 a rain-on-snow event caused the lake to overflow and quickly cut through the glacial material at the outlet. Downstream reaches below the lake are still recovering from the major flood that resulted. Along some reaches, the channel cut as much as 60 feet, and massive deposition occurred in downstream low gradient valley reaches. The lake's outlet is still unstable and what remains today is a small young wetland.

Like Betts Meadows and Horseshoe Lake, **Woodward Meadows** has changed relative to reference conditions. It was drained, seeded for pasture, and fenced in the 1950's. By 1963, National Forest System grazing records noted that the meadow was exhibiting a downward trend due to heavy cattle use and flooding by beaver. In 1966, clearing increased the meadow by 12 acres and today, there is twice as much land cleared around the perimeter of the meadow as existed in 1951. Beaver are present in the wetland as evidenced by the 6 intact dams along Cottonwood Creek.

Water Quality

The direct beneficial uses of water within the analysis area are stock watering, irrigation, fisheries, grazing, wildlife, residential, and dispersed recreation. Indirect beneficial uses downstream of the analysis area, within the Colville River Basin are residential/industrial, fisheries, mining, irrigation, livestock, and wildlife.

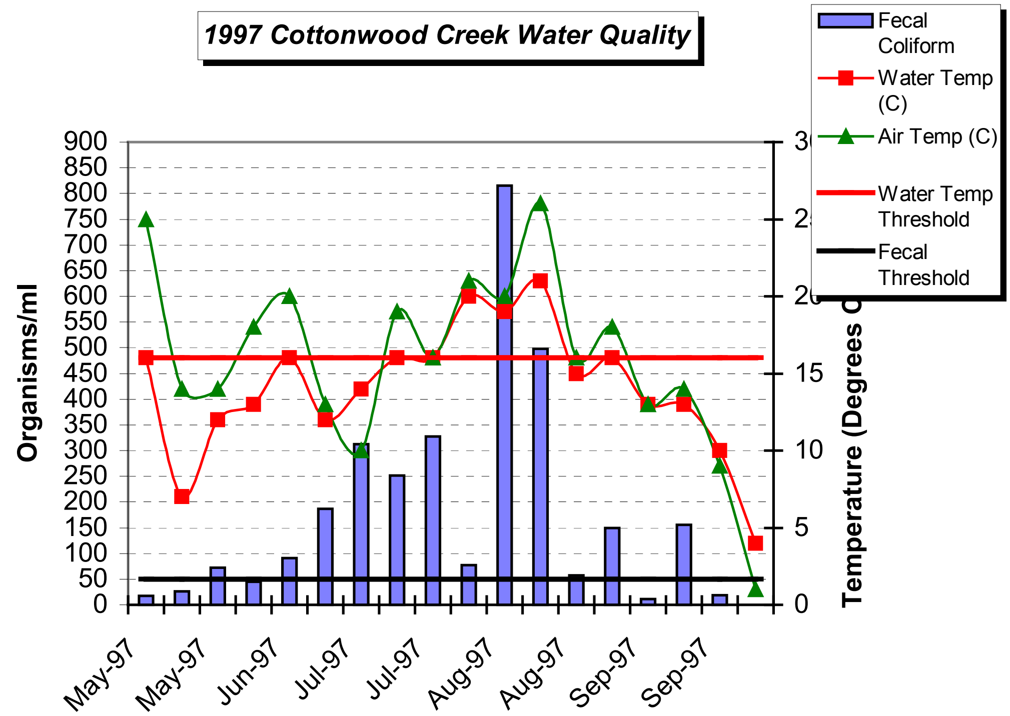
Waters within the analysis area must comply with Washington State water quality standards. In addition, WAC 173-201-070 states that "All surface waters lying within national parks, **national forests**, and/or wilderness areas are classified as Class AA or Lake Class.

Water Quality Parameters

Parameter	AA Waters	Lake Waters
Bacteria	<50 organisms/100ml	<50 organisms/100ml
Dissolved O_2	>9.5 mg/L	No change from background
Temperature	<16°C	No change from background
pH	6.5-8.5	No change from background
Turbidity	<5 NTU	<5 NTU

Water quality data across the analysis area is scant at best. Most areas have not been monitored and consequently, adherence to Washington State water quality standards is unknown. One area of concern however was reported by the 1996 Washington State Water Quality Assessment, Section 305(b) Report (August 1996). In that report, Cottonwood Creek is listed as impaired for fecal coliform. Fecal coliform bacteria are derived from the feces of humans and other warm-blooded animals. These organisms enter stream systems through direct discharge from mammals and birds; from agricultural and storm runoff containing mammal and bird wastes; and from sewage discharge. Even though fecal coliform bacteria are not pathogenic, they occur along with pathogenic organisms. Their presence, therefore, suggests the occurrence of disease-causing organisms.

Data collected weekly on Cottonwood Creek during the 1997 field season indicates that fecal coliform counts still exceed Washington State water quality standards.



In forested areas, high levels of coliform bacteria are usually associated with inadequate waste disposal by recreational users, the presence of livestock or other animals in the stream channel or riparian zone, or poorly maintained septic systems. The Monitoring site was located on the mainstem of Cottonwood Creek just below a beaver dam where the stream flows out of the west end of Woodward Meadows. Livestock can be ruled out as a possible source of contamination because none have used the site since 1986. Dispersed recreation sites in Woodward Meadows are located on upland benches outside the zone of riparian influence. These sites receive their greatest use during the fall hunting season, which is also the period of lowest flows in these streams. For this reason, dispersed recreation has also been eliminated as a cause of the elevated fecal counts. The access into the Betts Meadows Wetland Preserve is restricted and no residential developments exist above the sampling site. So, by a process of elimination, the sources of fecal coliform above the sampling site, point to the shallow beaver ponds of both Betts and Woodward Meadows, and are the result of wildlife species that inhabit this area.

Section 3.3 - Vegetation

What are the current conditions and trends of the prevalent plant communities and seral stages in the analysis area? What is the reference array and landscape pattern of plant communities and seral stages in the analysis area and what processes caused these patterns? What is the current condition of riparian vegetation? How does this compare to reference conditions? What biophysical environmental settings are present in this analysis area? How do their current conditions compare to reference conditions? How have upland structural conditions changed from reference conditions? How have changes in species composition, forest density and forest structure changed the resiliency of the landscape to fires, insects and diseases? How has fire suppression affected the character and arrangement of upland stands?

Upland Forests

Ecosystem analysis uses a “patch-corridor-matrix” model to detect the general spatial patterns and principles of landscapes. Patches are defined as homogenous non-linear areas that differ from their surroundings (burned areas, clear-cuts, old forests). A corridor is a strip of a particular type that differs from the adjacent land on both sides (a hedgerow between pastures, riparian vegetation between upland forest). And the matrix is the background ecosystem or land-use type, which is characterized by extensive cover and connectivity.

Because 80% of the analysis area is classified as forestland, forests provide the background matrix over which patches and corridors are spatially arranged. The current arrangement of these three basic landscape components was produced by past natural and human-caused disturbances (fire, weather, insects and diseases, timber harvest, roads).

Interior forest landscapes like the Quartzite Analysis Area developed from disturbances caused by nature and people. Humans have occupied lands in the area for at least 9,000 years. The physical imprint left by indigenous people is diffused and unobtrusive, however, landscape patterns following the in-migration of Europeans and others are more easily recognized. The evidence of mining and logging operations, homesteads, livestock camps, roads, and trails, can be seen across the analysis area.

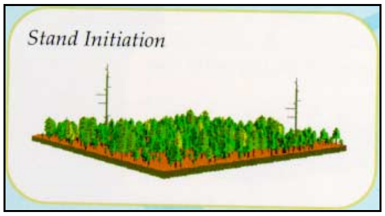
Biophysical Environments and Vegetation Structure

A biophysical environment (BPE) is distinguished by its *potential natural* vegetation and its fire ecology regime. The delineation of four distinct BPE’s within the analysis area provides a context for the analysis of forest matrix, patches, and corridors over time. The composition, structure and density of vegetation for each BPE can be compared between reference conditions and current conditions by using forest structural classification.

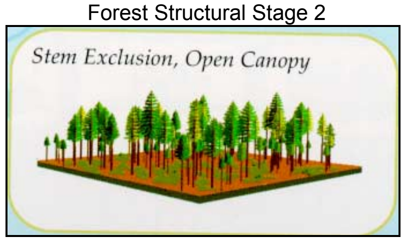
Structural Stages

As forests grow, they progress through different developmental stages or structures. Forest structure describes the size arrangement of trees and other plants.

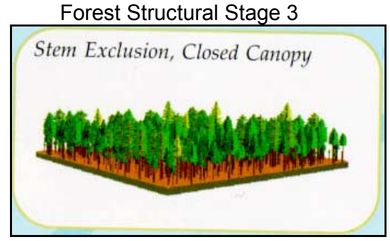
Forest Structural Stage 1



Forest Structural Stage 2

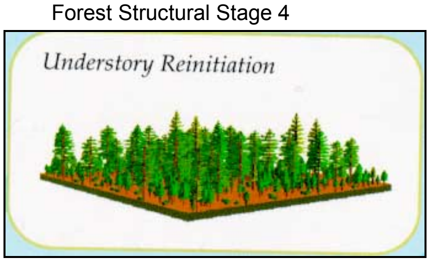


Forest Structural Stage 3

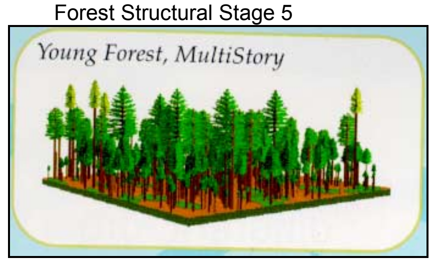


Stand Initiation through Stem Exclusion (Stages 1-3). These early stands are fully stocked by conifer trees that may range in size from seedlings through 15" diameter trees. The distinguishing characteristic is that all the trees are near the same age (same cohort), and all the trees are in the same canopy layer. A second canopy layer of shade tolerant trees has not yet started to develop in the understory.

Forest Structural Stage 4

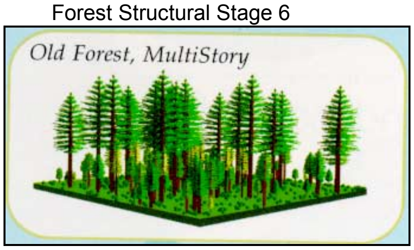


Forest Structural Stage 5

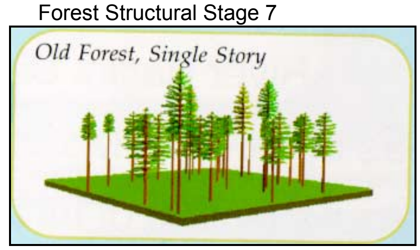


Understory Reinitiation and Multi-Stratum without Large Trees (Stages 4 & 5). A second cohort of trees is established under an older overstory in these middle stages. Openings start to appear in the canopy, and the amount of down wood increases. The trees in the overstory are typically seral (larch, pine, Douglas-fir, etc.) while the trees in the understory are typically shade-tolerant (western redcedar, hemlock). The stand may contain many sizes of trees, but large trees are uncommon.

Forest Structural Stage 6



Forest Structural Stage 7



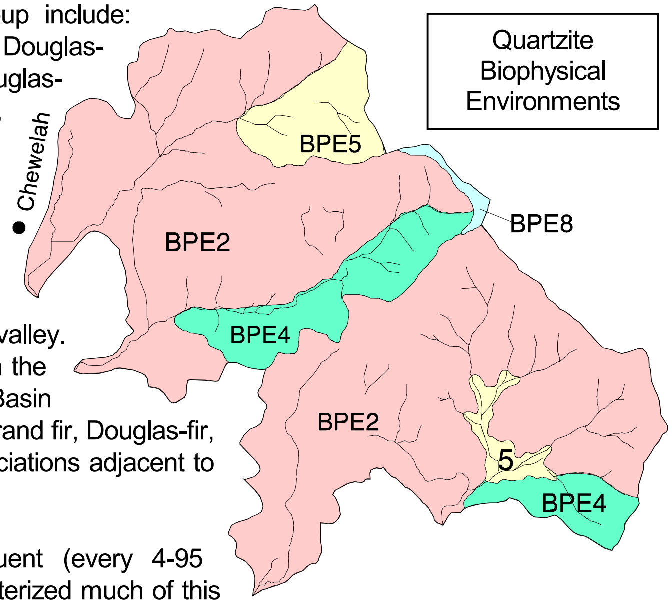
Multi-stratum with Large Trees (Stage 6). These late and old stands contain two or more cohorts of trees, and trees of all sizes are present. The overstory canopy is discontinuous, and dominated by large trees.

Single-Stratum with Large Trees (Stage 7). A single layer of large seral trees is present in this late and old stage. The understory may be absent or may contain sparse or clumpy seedlings and saplings. These stands are sometimes called park-like.

Biophysical Environments

Biophysical Environments (BPE) are used as the common unit with which to compare the distribution of the seven structural stages over time. Using *potential natural* vegetation and fire ecology, four BPEs were mapped in the analysis area.

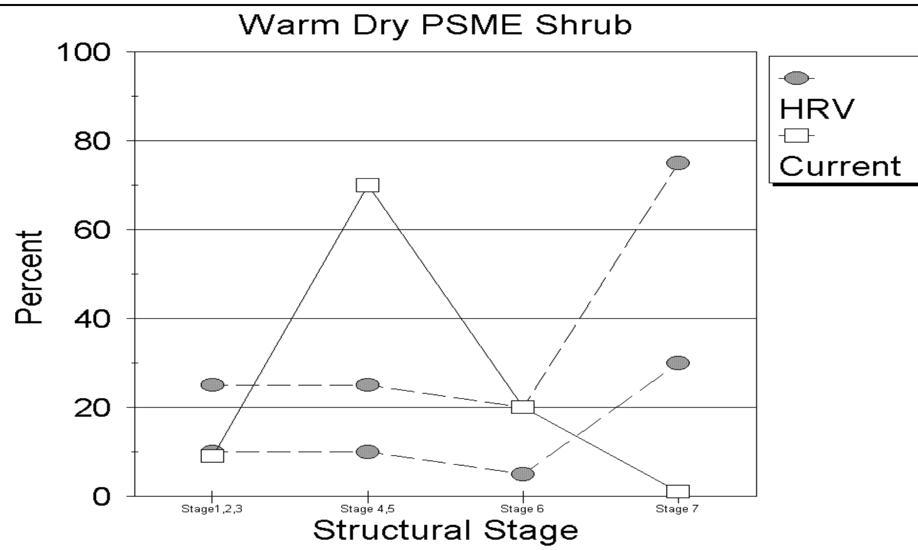
Warm Dry Douglas-fir/shrub (BPE2) Over 80% of the analysis area falls within this BPE. It is characterized by warm Dry Douglas-fir/grand fir with shrub understories. The plant associations for this group include: Douglas-fir/ninebark, Douglas-fir/ninebark-twinflower, Douglas-fir/common snowberry, Douglas-fir/mountain snowberry, and grand fir/ninebark. The Douglas-fir series is most conspicuous on the southerly slopes of upper Sherwood Basin and flat bottomland in the Colville River valley. Grand fir/ninebark is present on the south aspects of Betts Basin interspersed with more mesic grand fir, Douglas-fir, or western redcedar plant associations adjacent to narrow riparian areas.



During reference times, frequent (every 4-95 years) low intensity fires characterized much of this biophysical environment. Fires generally kept stands open and free of fire-intolerant species, while maintaining seral species such as ponderosa pine, as well as larger diameter fire resistant Douglas fir. In some areas, low intensity fires stimulated shrubs and grasses, maintaining vigorous browse and forage. The shrub layer could either inhibit or contribute to potential fire behavior, depending on weather and live fuel moisture conditions at the time of the burn. Stands tended to have older, large diameter overstory trees, interspersed with areas of young pole and sapling-sized reproduction. When a low-intensity fire occurred these thickets of younger trees were often killed, maintaining stands of large diameter seral species in an open, park like condition. The absence of a dense understory prevented flame lengths from reaching the crowns of the overstory.

Severe high intensity fires in which entire stands were destroyed, occurred after abnormal fire free intervals in patches of the forest matrix where forest succession contributed to an increase in surface and ladder fuels. While more severe than the more frequent low intensity fires, these fires occurred less frequently (every 170 years) over smaller areas within BPE 2.

The distribution of forest structural stages during reference conditions (HRV) is expressed as a percentage of the BPE area. During reference conditions, 10 to 25% of BPE 2 (Warm Dry PSME Shrub) was occupied by stages 1, 2 & 3. Ten to 25% of the area was occupied by stages 4 & 5. Five to 20% was occupied by stage 6 and 30 to 75% was occupied by stage 7. The range in percentages represents the dynamic nature of landscapes and highlights the interplay of potential natural vegetation and reference fire regimes within the ecosystem.



The current spatial pattern of forest structural stages across BPE 2 show a disparity between reference conditions and current conditions for all but Stage 6. Reference conditions show a shifting mosaic of between 5,600 and 14,000 acres of Stage 7 in BPE 2. But today, only 193 acres of Single-stratum SS7 are located in this BPE. The current quantity of Stage 6 is within its reference range of variability. However, some of these SS6 stands are located on drier south and west facing sites, where fire historically maintained less dense, more open park-like SS7 stands of ponderosa pine, western larch, and Douglas-fir.

Shade-tolerant ladder fuels in the understory are generally becoming homogenous across BPE 2. Once maintained by periodic low to moderate intensity fire, many stands are becoming predisposed to higher severity fire due to aspect, fuel loading, and ladder fuels. The forest matrix in BPE 2 is more uniform and has fewer patches now compared to reference conditions.

Current structural stage distribution also shows the effects of ownership and accessibility on land use. Large diameter SS6 and SS7 stands are generally located on less accessible NFS Lands, while earlier stages dominate the more accessible non-NFS Lands.

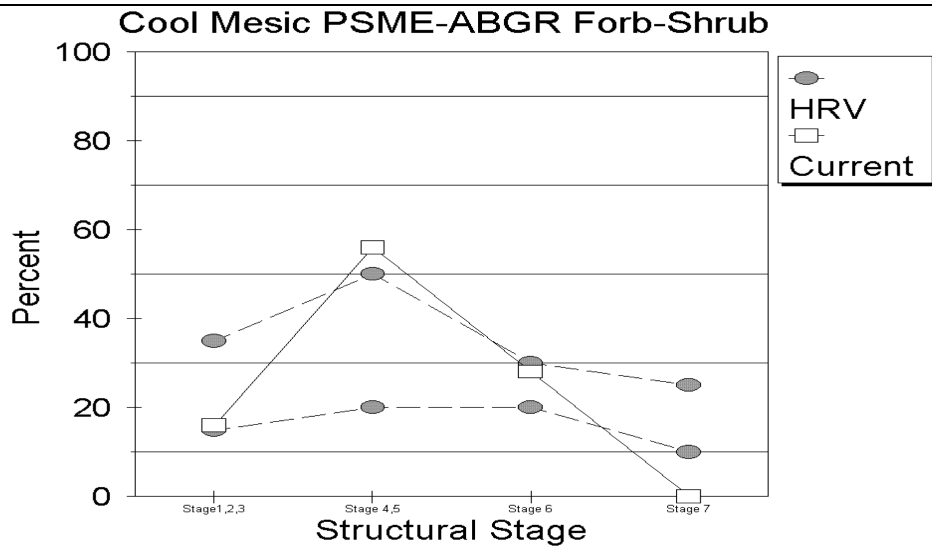
Cool Mesic Douglas-fir grand fir/forb-shrub (BPE 4). This biophysical environment occupies 11% of the analysis area and is characterized by Cool Mesic Douglas-fir/grand fir with forb-shrub understories. The plant associations for this BPE include Douglas-fir/dwarf huckleberry, Douglas-fir/big huckleberry, grand fir/queencup beadlily, grand fir/dwarf huckleberry, grand fir/big huckleberry, grand fir/Douglas-maple. It is typically found on more northerly aspects of the Quartzite analysis area.

Reference fuel amounts varied and fire behavior ranged from stand replacing fires to low intensity fires, producing a mixture of even-aged stands with occasional large, old trees and a species mixture of young trees. The fire regime was more variable in this biophysical environment than in BPE 2. Areas in BPE 4 that experienced frequent low intensity fires, typical burned from a few hundred to a few thousand acres. Areas with less underburning and more frequent stand-replacing fires, were probably larger in size . Fire history studies in similar areas show stand replacing fires occurring at intervals of less than

100 to 141 years. Where fires burned in patchy mosaics of stand replacing and low intensity, the mean fire-free interval was 50 to 100 years.

Considerable variety can be found in structure and composition of mature forests in this biophysical setting. Two major successional pathways describe this process. In Douglas-fir, ponderosa pine or western larch successional pathways low intensity fires would remove most vegetation leaving scattered ponderosa pine and western larch. Fire thinned stands would mature into open forest with Douglas-fir and Engelmann spruce understories. In pathways dominated by lodgepole pine most stands were renewed by stand-replacing fire intervals of less than 150 years.

During reference conditions (HRV), 15 to 35% of BPE 4 (Cool Mesic PSME-ABGR Forb-Shrub) was occupied by stages 1, 2 & 3. Twenty to 50% of the area was occupied by stages 4 & 5. Twenty to 30% was occupied by stage 6 and 10 to 25% was occupied by stage 7.



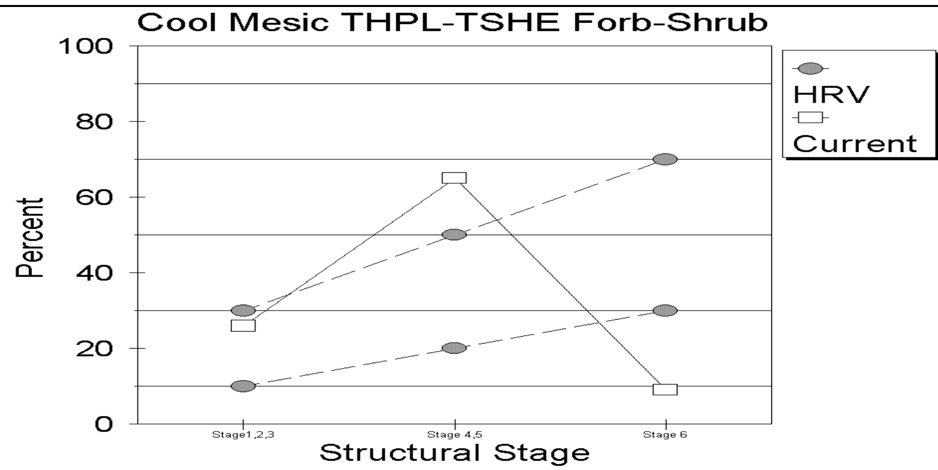
While not as extreme as BPE 2, the disparity between reference and current structural conditions in BPE 4 is most evident for Stage 7. Once maintained by periodic low to moderate intensity fire, stands that would have been Stage 7, now have the structure of Stage 6 stands. These stands are becoming predisposed to higher severity fire due to higher fuel loading, ladder fuels, and seral species elimination due to logging, insects and disease. Like BPE 2, fire exclusion in BPE 4 has caused the current forest matrix to become more uniform with fewer patches.

Cool Mesic cedar-hemlock/forb-shrub (BPE 5). This biophysical environment is found mostly on low elevation, low gradient wetlands and on higher elevation north-facing slopes, where precipitation is plentiful. It is the third most widely distributed biophysical environment in the watershed at 1,763 acres, or 7% of the analysis area. This biophysical environment is characterized by Cool Mesic Western Redcedar with forb-shrub understories. The plant associations for this group include western redcedar/queencup beadlily, and western redcedar/big huckleberry.

Although fuel loading can be quite high in these stands, fire hazard is usually low, due to the high humidity in the understory throughout much of the summer months. In addition, green shrubs and other understory vegetation help act as a “heat sink” in both young and older, “parklike” stands. Thus, old-growth stands are often resistant to low-intensity fire, because the crowns of the larger trees can often survive torching of ladder fuels. However, during drought periods, when surface fuels dry out, fires may smolder for long periods of time, causing more severe fire effects. Once live fuel moisture decreases, conditions leading to stand-replacing fires will increase. Stand-replacing fires do not usually consume the entire duff layer, and can actually increase the amount of dead and downed fuels, as snags and other dead wood fall over in the years following the burn. In addition, after a stand is opened to sunlight by fire or some other disturbance, it will dry more quickly during the season, and thus may be more susceptible to re-burns and extreme fire behavior.

The structural complexity and species diversity of forests found within BPE 5, help create variable fire regimes. Although stand-replacement fire at intervals of 50-150 years may have generally been the case, historic fires varied in uniformity of severity with topographic influences affecting patch size and distribution. Upland sites with slopes greater than 30% were more apt to have stand-replacement events with patch sizes from 50-500 acres but with intermixed variable severity underburning. Even within a generally severe fire, non-lethal underburning could occur during moist periods and near the downslope and downwind edges. The more southerly aspects at lower elevations generally exhibited lower intensities, while low elevation riparian environments burned rarely.

During reference conditions (HRV), 10 to 30% of BPE 5 (Cool Mesic THPL-TSHE Forb-Shrub) was occupied by stages 1, 2 & 3. Twenty to 50% of the area was occupied by stages 4 & 5 and 30- 70% was occupied by stage 6. Stage 7 did not occur in BPE 5.

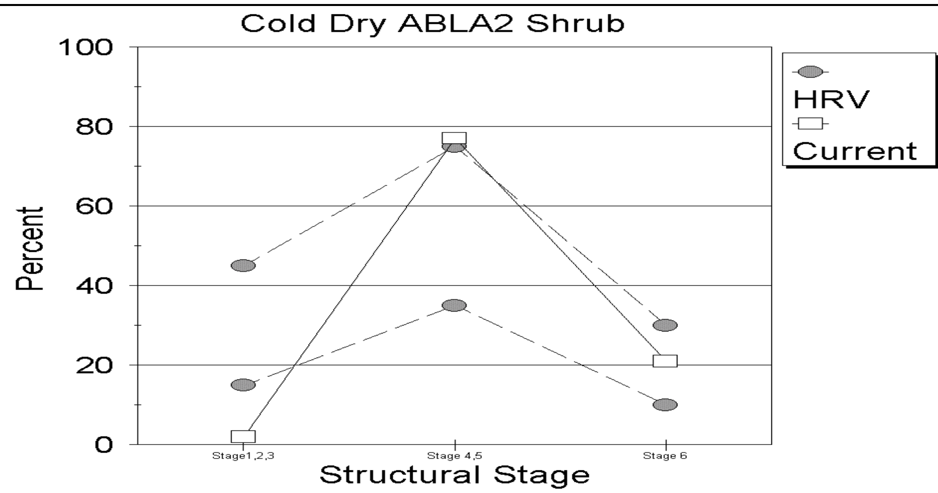


Current structural stage distributions in BPE 5 show a preponderance of small diameter, less structurally diverse stands. The effects of converting low elevation wetland forests to pastures are evident in the small amount of Stage 6 relative to reference conditions. The homogeneity of the forest matrix is also increasing in BPE 5, with fewer patches and structural complexities. Although BPE 5 had a longer fire return interval than the BPE 2, and was more apt to have stand replacement fire, the uniformity across the landscape is creating conditions that favor larger, more severe fires.

Cold Mesic subalpine fir/forb-shrub (BPE 8). This biophysical environment makes up 1% or 156 acres of the analysis area. It is found on the upper un-glaciated slopes of the west ridge of Chewelah Mountain. Subalpine fir and mountain hemlock are the climax tree species. Early succession is mostly dominated by lodgepole pine or by a combination of other tree species including Douglas fir, Engelmann spruce, grand fir, western white pine, western larch and whitebark pine. The successional pattern for a particular stand depends not only on habitat type but also on past fire history, seed source and local conditions.

Reference fire regimes in BPE 8 are relatively complex. Large, stand-replacing fires burned through thousands of acres at intervals ranging from 117 years to 150 years. Although variable, the frequency of stand-replacing fires tended to decrease with increasing elevation because trees grow more slowly causing fuels to accumulate more slowly. Fires that started at higher elevations are usually lower in intensity; the stand-replacing fires were those that swept uphill from lower forests.

During reference conditions (HRV), 15 to 45% of BPE 8 (Cold Dry ABLA2 Shrub) was occupied by stages 1, 2 & 3. Thirty five to 75% of the area was occupied by stages 4 & 5 and 10-30% was occupied by stage 6. Stage 7 did not occur in BPE 8.



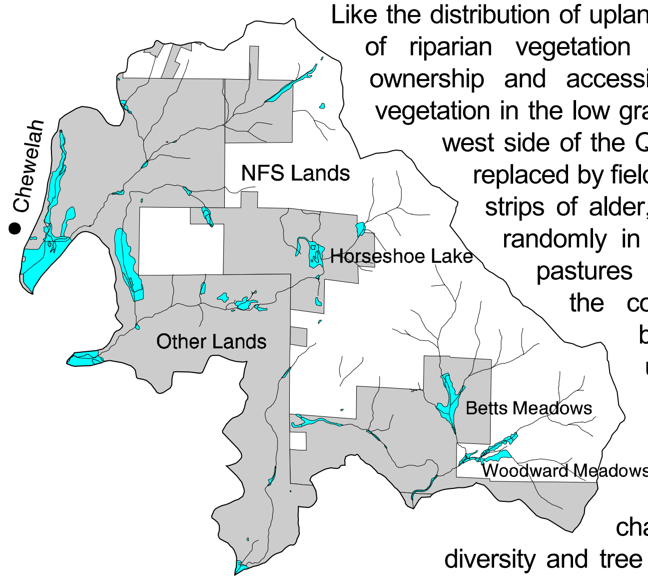
While being the smallest BPE in the Quartzite Analysis Area, compared to other BPEs, the current forest structure condition of BPE 5 is closest to reference conditions. Deficits in early stages may be attributed to the suppression of ridge top lightening strikes in the recent past.

Riparian Vegetation

The availability of site resources differentiate growing conditions in riparian areas from upland forested areas. Unlike upland areas, water and nutrients are available throughout the growing season in most riparian areas. In response to these conditions, riparian vegetation increases in species diversity and structural diversity. It is this diversity in vegetation that differentiates riparian areas from the background forest matrix which by definition, identifies these linear stream-side strips as the most common corridor type within the Quartzite Analysis area.

Understanding the role of Quartzite vegetative riparian corridors in the ecosystem is important because of their contribution to ecological processes and societal goals. Intact corridors provide biodiversity protection across the landscape by providing habitat for rare and endangered species, and wide-ranging species and by providing dispersal routes for recolonization following local extinction. They enhance water resource management, such as flood control, sediment control, clean water and sustainable fish populations. And they provide a variety of recreation opportunities.

Reference disturbance events in riparian areas included fire, (see the preceding upland Forest BPE 5 discussion), but fire played a much smaller role in forest succession in these areas, than in upland areas. Other disturbances included peak-flow stream events and flooding by beaver. Reference riparian vegetation and corridor width varied by elevation and stream gradient. The lowest reaches of Thomason, Sherwood and Cottonwood Creeks shared the conditions of the Colville River Valley, where large diameter cottonwood trees, ponderosa pine, and grand fir populated the broad riparian areas. As elevation and stream gradient increased, reference riparian zones became narrower and western red cedar replaced ponderosa pine and grand fir. The presence of cottonwood extended upstream where gradients flattened and riparian areas broadened. Forest structural stage 6 (multi-stratum with large trees) typified all but the upper most reaches of streams, where upland disturbance events overwhelmed most narrow riparian areas. Small breaks in riparian corridor continuity between the valley floor and the upper reaches occurred with beaver flooding and the rare stand replacing fire.



Like the distribution of upland structural stages, the condition of riparian vegetation today reflects the effects of ownership and accessibility. The reference riparian vegetation in the low gradient low elevation areas on the west side of the Quartzite Analysis Area has been replaced by fields, pastures and homes. Narrow strips of alder, cottonwood and conifers occur randomly in this valley floor area. Roads, pastures and logging, regularly interrupt the continuity of riparian vegetation between the valley floor and upland stream reaches. However, stands of small diameter mixed conifers are interspersed with these openings and as ownership changes to NFS Lands, structural diversity and tree diameters increase. Conditions in the narrow upper stream reaches on NFS Lands are near reference conditions, with many stands characterized as multi-stratum with large trees. But these too have been affected by fire suppression, and the increase in fuel within riparian areas and in adjacent upland areas, poses an increased of risk of fire to existing structural stage 6 riparian vegetation.

Other Vegetation

Two other vegetation categories of concern for land management are noxious weeds and sensitive plants. Both are present on NFS Lands, where surveys were conducted. Surveys for sensitive plants were not conducted on non-NFS Lands, however they are suspected in wetland and other habitats, where their occurrence is likely. Noxious weeds are known to occur along roads outside of NFS Lands.

Noxious Weeds

A weed is a plant growing where it is not desired; or any plant that is a nuisance, hazard, or causes injury to humans, animals, or desired plants. Noxious weeds are arbitrarily defined by law as being especially undesirable, troublesome, or difficult to control. As noted in Chapter 1, they are species that have been introduced into North America from European, Asian, and Mediterranean countries. These species have little or no natural competition or controlling agents on this continent and are often considered weeds in their native environments because of their invading, pioneering, or aggressive characteristics.

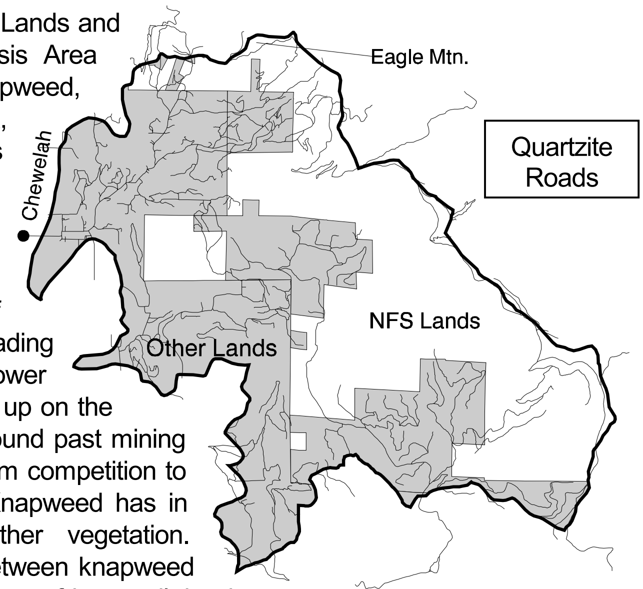
Reference conditions for noxious weeds are easily described. Noxious weeds did not occupy the Quartzite Analysis Area until the in-migration of Europeans and others. The current condition however, is the result of a century of activity in the analysis area. Many species arrived on the North American continent with settlement by Europeans. Mode of arrival included contaminated grain and seed, ship ballast, livestock hay or feed, and sheep wool, attached or not. Some weeds arrived intentionally for ornamental or landscaping uses. These introduced species then invaded the continent in a "reverse watershed" pattern, generally following the waterways from the coast to the headwaters, following settlement patterns. Improved methods of travel, including the railroads and steamboats, promoted this spread.

In addition to the natural movement of seed and plant material by wind and animals, there are many other mechanisms for movement. These include trapping, homesteading haying of meadows, road and trail construction, mining, gravel pits, timber harvest and regeneration, prescribed and other man-caused fires, fire protection, a variety of recreation activities, livestock grazing, pasture improvement, and soil cultivation.

Areas with soil disturbance or vegetation loss are the most susceptible to noxious weeds and repeated disturbance or loss increases susceptibility. Changes in vegetation type or site health also makes sites more susceptible to noxious weeds. Most noxious weed species prefer open, hot, dry, or well drained sites, however, there are noxious weed species within the analysis area that are adapted to moist sites. Cool-mesic and closed canopy sites are most resilient to noxious weeds. Sites with an open canopy and either hot to dry or very moist conditions are most susceptible.

The equipment, animals and humans that expose bare soil and thus create habitat for noxious weeds are also vectors for noxious weeds. Vehicles and equipment move seed, including those not directly involved in soil disturbances or loses of vegetation. Seed is carried by snagging vegetation with seed heads or in dirt found on the frame, undercarriage, grill, or internally on vehicles and equipment. This may happen with non-motorized as well as motorized vehicles and equipment used on or off designated roads. Hay and feed stuffs used for livestock may contain noxious weed seed. Livestock that have been on infested pasture or have eaten contaminated hay or feed stuffs within a few days before entering or moving within the analysis area may pass seed through their manure. Humans may carry barbed seeds in their gear, clothing, or shoes. Recreationists import seeds on tents, ATV's, and other equipment from other areas. The use of seed that is not free of noxious weed seed for construction or restoration projects is another contributor to the introduction of noxious weed seed, as is the dumping of refuse or yard trash.

Almost all human activities have concentrated along the transportation systems (roads and trails), meadows, and creeks within the watershed. Many of the current transportation routes lie along the same routes as did historical ways, trails, and roads. In recent decades, expansion of these routes and additions of new routes have occurred. It is not a coincidence that noxious weeds have expanded the same way.



Noxious weed surveys on both NFS Lands and other lands in the Quartzite Analysis Area identified diffuse and spotted knapweed, yellow hawkweed, dalmatian toadflax, oxeye daisy, goatweed, hound's tongue, tansy ragwort, bull and Canada thistle, common mullein and reed canary grass.

Noxious weed infestations of knapweeds and goatweed are degrading the vegetation and soil condition in lower elevations along travel corridors and up on the slopes of Eagle Mountain in and around past mining activity. This degradation comes from competition to other more desirable vegetation. Knapweed has in many places nearly excluded other vegetation. Because of the large interspaces between knapweed plants, these sites have a large amount of bare soil that is susceptible to erosion and nutrient leeching. In places, this erosion is contributing to the sediment in streams.

Reed canary grass infestations in Betts and Woodward Meadows are well established and continue to displace native wetland species.

Sensitive Plants

Field surveys of National Forest System Lands yielded 20 populations of those plants recognized by the National Forest System as sensitive plants. All were located within three specialized habitats: forested riparian habitat; wetland/wet or dry meadows/pond habitats; and open forest and rocky outcrop habitat.

Reference conditions for sensitive plants are inferred from reference biophysical environment conditions. The relationship of the current location of sensitive plants with forest structure, potential natural vegetation and disturbance events helps identify the reference distribution of sensitive plants.

Current conditions for plants that favor forested riparian habitat show a deficit of habitat compared to reference conditions, especially along the low elevation, low gradient reaches of area streams (see the previous Riparian Vegetation discussion in Section 3.3). However, various populations of moonwart species are located on NFS Lands along narrow riparian corridors, where large, old cedar is found. There are roughly 200 acres of this habitat type located on NFS Lands today, where reference conditions range between 300 and 3,000 acres. Excessive fuel loads in and adjacent to current habitat threaten its longevity.

Wetland/wet or dry meadows/ponds habitat provides the greatest potential for a variety of sensitive plants in the analysis area. Wetland inventories catalogue roughly 850 acres of wetlands within the analysis area, representing 4% of the total. Ninety percent of these occur on private lands at the lower reaches near the Colville River valley. While wetlands still exist on private lands, the conversion to agriculture and ranching has greatly altered them and introduced plant species have most likely eliminated any sensitive plant species that previously occurred there. Many upland meadows have experienced similar alterations (see the Wetlands discussion in Section 3.2). Two sensitive species were found on NFS Lands in upland meadows.

Scattered rocky outcroppings comprise roughly 1700 acres or 7% of the analysis area. Quartzite Mountain and associated thrust faults along the eastern edge of the Colville River Valley provide habitat for a small group of sensitive plant species that grow on cliffs and outcroppings of limestone and talus slopes.

The sensitive pine broomrape plant requires healthy oceanspray in open stands of Ponderosa pine with pine grass. Reference conditions for BPE 2 show that between 30-75% of the area was comprised of similar stands. The fires that regularly frequented these areas rejuvenated the decadent older oceanspray plants and kept the openings free of invading Douglas fir. Fire suppression over the last several decades has allowed Douglas fir to displace oceanspray and populations of pine broomrape have declined.

Section 3.4 – Species and Habitats

What are the current conditions and trends of the species of concern? What was reference relative abundance and distribution of species of concern and the condition and distribution of their habitats in the analysis area? How do wildlife species use riparian corridors? What vegetation conditions are important? How does the current condition compare to reference conditions? How have changes in riparian condition affected dependent species? How do changes in species composition, forest density and forest structure affect wildlife habitat? Has habitat diversity changed relative to reference conditions? How has fire suppression affected species dependent on old forest-single story structure? How have changes in species composition, forest density and forest structure affected species dependent on old forest mult-story structure?

An ecosystem is an area where species interact with the physical environment, and a community is the assemblage of interacting species in an ecosystem. A precept of ecosystem analysis is that native species have evolved with reference disturbance regimes and the landscape patterns of habitats resulting from those regimes. Native species diversity and associated ecosystem functions and processes therefore are inextricably linked to the spatial patterns of patches, corridors and matrix across the landscape.

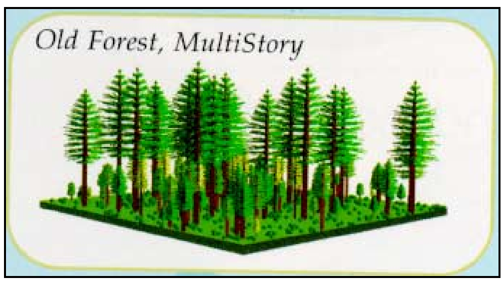
The Quartzite Analysis Area has a variety of wildlife habitat types, ranging from high ridges to dense forests to cleared agricultural lands. The ridges and riparian vegetation serve as travel corridors for many species. The Colville River valley connects the area with the Columbia River valley, and provides access to the area for many birds and other species. Fields and logging areas create patches in the background forest matrix and roads interrupt many riparian corridors. Road density across the Quartzite Analysis Area averages 3.84 miles per square mile. The road density on National Forest System Lands is 2.01 m/m^2. As noted in Chapter 1, an isolated block of unroaded upland forest habitat, roughly 5,000 acres in size is located on National Forest System Lands on the east side of the area.

Analysis focuses on species that are dependent on reference habitat conditions that are currently absent, or are significantly different compared to reference conditions. Landscape elements divide the analysis into two general habitat types: upland forest habitats represent patch and matrix elements, and riparian habitats represent corridors.

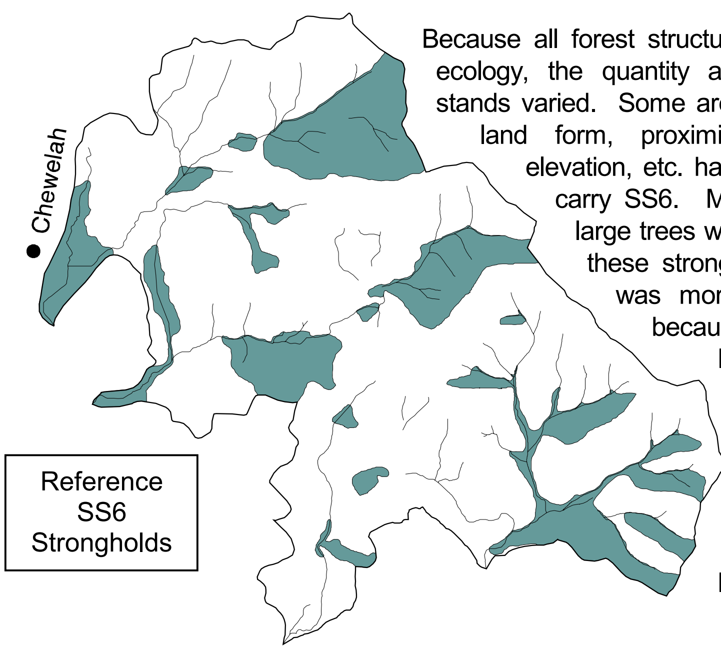
Upland Forest Habitats

Species of concern for upland forest habitats include pileated woodpecker, pine marten, northern goshawk, barred owl, white-headed woodpecker, flammulated owl, lynx, gray wolf, grizzly bear, and ungulates. Reference habitat conditions of concern are seclusion, and the landscape patches created by two forest structural conditions: stands with multi-stratum structure and large trees (SS6); and single-stratum stands with large trees (SS7).

Multi-stratum Habitat with Large Trees

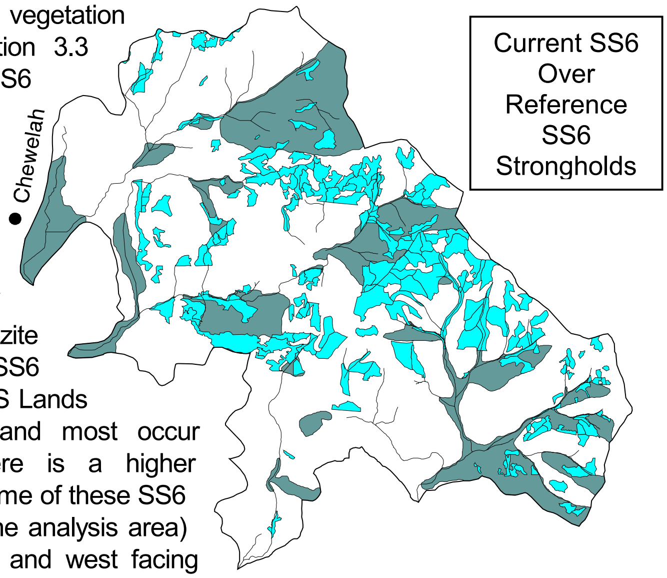


These diverse SS6 stands offer foraging and/or denning and nesting habitat for pileated woodpecker, pine marten, northern goshawk, lynx and barred owl. The reference distribution of SS6 across the landscape was dependent on potential natural vegetation, and fire ecology. Vegetation-Section 3.3 of this chapter describes the vegetation conditions within the four biophysical environments identified in the analysis area, including the reference distribution of SS6. The amount of SS6 stands in BPE 2 ranged from 5% to 20%; BPE 4 carried 20-30%; BPE 5 carried 30-70%; and BPE 8 carried 10-30%.



Because all forest structure is dependent on fire ecology, the quantity and distribution of SS6 stands varied. Some areas, because of aspect, land form, proximity to riparian areas, elevation, etc. had a higher probability to carry SS6. Multi-stratum habitat with large trees was not always present in these strongholds, but SS6 habitat was more likely to occur here because these areas were less likely to experience structure changing fire events. A combination of riparian corridors and the background forest matrix provided travel linkages between SS6 patches, with occasional interruptions by early structural patches.

The current condition vegetation analysis displayed in Section 3.3 shows that reference SS6 *quantities* for all but BPE 5 (7% of the analysis area) are within reference ranges. However, the current *location* of SS6 serves as the basis for including it as a habitat of concern for the Quartzite Analysis Area. Few SS6 stands occur outside of NFS Lands at the lower elevations, and most occur outside areas where there is a higher probability to carry SS6. Some of these SS6 stands in BPE 2 (80% of the analysis area) are located on drier south and west facing sites, where fire historically maintained less dense, more open park-like SS7 stands of ponderosa pine, western larch, and Douglas-fir. Fire suppression and the accumulation of 60 years of both dead and live fuels in these areas has increased the threat of stand replacing fires.



The continuity of riparian travel corridors between the Colville River Valley and existing SS6 stands is compromised by roads, pastures, and logging (see the riparian vegetation discussion in Section 3.3). The background forest matrix however, in most areas is intact and linkages between SS6 habitat exist.

Single-stratum Habitat with Large Trees

White-headed woodpecker, and flammulated owl use single stratum habitat with large trees for foraging and/or nesting. Their use favors open stands of large diameter ponderosa pine and Douglas-fir. This habitat type is generally limited to drier moisture limited sites within BPE 2 and BPE 4. Reference fire regimes included frequent, low intensity fires that favored fire resistant ponderosa pine and allowed large trees to develop with little competition from below. These conditions were relatively common, especially at lower elevations where summer temperatures are high and precipitation is low; and on south and west facing slopes, where solar radiation dries fuels. Reference vegetation analysis shows that SS7 habitat occupied from 24-58% of the analysis area.

Current vegetation condition analysis shows that less than 1% of the analysis area has single stratum habitat with large trees. Most reference SS7 habitat located outside NFS

Lands was logged over the past 100 years because of its high commercial value. Most reference SS7 habitat located within NFS Lands has acquired a second or third cohort and as noted in the preceding discussion, has become SS6 habitat. Using the precept that these native species have evolved with reference disturbance regimes and with the SS7 landscape patches that result from them, the decline in habitat infers a corresponding decline in the number of white-headed woodpecker and flammulated owl.

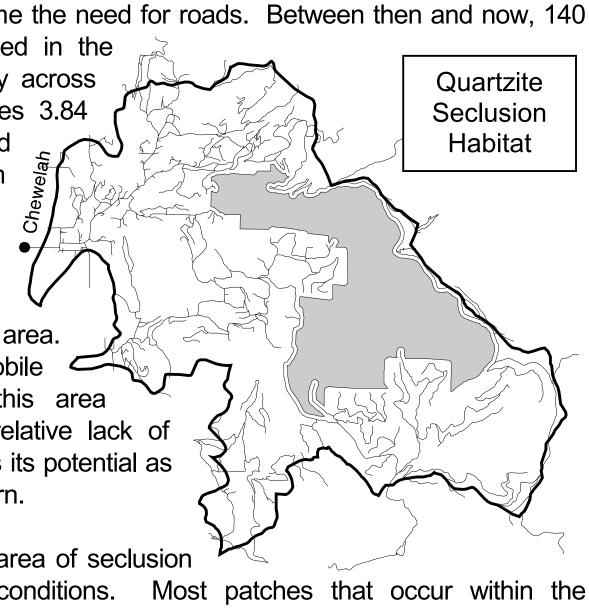
Seclusion Habitat

While most species only require small areas for seclusion, some large-home-range vertebrates require large blocks of core habitat and escape cover. Gray wolf, grizzly bear and ungulates are among the latter. The home ranges for these species can cover many watersheds that collectively provide a variety of key habitat types, one of which is seclusion habitat.

Because of the habitat penetration provided by roads, their presence is an indicator of seclusion habitat within a species home range. Their presence within the Quartzite Analysis Area and in adjacent watersheds causes seclusion habitat to be a habitat of concern for this analysis.

The oral history of indigenous people indicates lower valley areas were used for camas gathering and for accessing the salmon fishery at Kettle Falls. Upland areas were used for berry picking and hunting game. One or two trails that crossed the ridge on the east side of the analysis area may have been used to travel between the Colville and Pend Oreille River Valleys. However, the human influence on species of concern during reference times included very little mortality. Consequently, most of the area qualified as seclusion habitat during reference times.

The in-migration of Europeans and others began in earnest with homestead settlement from 1890-1930. With this influx came the need for roads. Between then and now, 140 miles of road have been constructed in the analysis area. Current road density across the Quartzite Analysis Area averages 3.84 miles per square mile. The road density on National Forest System Lands is 2.01 m/m^2. As noted above, an isolated block of unroaded habitat, roughly 5,000 acres in size is located on National Forest System Lands on the east side of the area. Because they are popular snowmobile routes, most roads that border this area experience year-round use. The relative lack of disturbance within this area increases its potential as seclusion habitat for species of concern.



This area represents roughly ¼ the area of seclusion habitat associated with reference conditions. Most patches that occur within the background upland forest matrix of this area are SS6 stands. The relationship of this seclusion habitat to other key habitat components for the home ranges of the species of concern is complicated by the scope of these ranges. However, the few grizzly bear and gray wolf sightings documented over the past 20 years indicate the area may only be used as transitory habitat between other preferred home ranges or that the habitat is not used.

A key habitat component for ungulates is winter range. This block of seclusion habitat includes very little ungulate winter range. However the interior provides quality escape cover from most predators.

Riparian Habitats

Species of concern for riparian habitats include fish, beaver, great blue heron, waterfowl, amphibians and neotropical migratory birds. The habitats of concern are the network of riparian corridors and wetlands that extend from the Colville River Valley into the upland forest matrix.

Both reference and current conditions of wetlands and riparian corridors have been discussed in previous sections. To avoid redundancy, please review the sub-section titled Wetlands in Section 3.2 (Hydrology), and the sub-section titled Riparian Vegetation in Section 3.3 (Vegetation). Both discussions note the disparity between current and reference conditions, especially in the lower elevations, where roads, pastures and logging have interrupted the continuity of riparian corridor habitat.

In-Stream Fish Habitat

The reference distribution of salmonids within the analysis area is strongly tied the Colville River. Currently Meyers Falls on the Colville River at Kettle Falls is a barrier to upstream migration of salmonids and other fish. Historically, after the last glacial retreat, Meyers Falls may have been passable to fish. This is supported by the presence of native fishes in the Colville River. Genetic studies on rainbow trout in the North Fork of Chewelah Creek show some remnant genes from redband trout, a native trout. Redband trout could have been stocked at some time, but the presence of some non-game fish such as redside shiners, sculpins, largescale suckers, and speckled dace indicate that the falls would have been passable. Non-game fish are usually not stocked. Because fishes in the Columbia would have had access to Meyers Falls, the native trout would have had the opportunity to move into the Colville River. Historically then cutthroat trout, bull trout, rainbow trout, and the nongame fish mentioned above occupied the Colville River. There are no fish blockages on the tributaries to the Colville in the Quartzite Analysis Area . It is assumed that the coldwater fish such as trout in the Colville River migrated freely into the Quartzite tributaries. The fish bearing streams in the analysis area are Cottonwood Creek, Thomason Creek, and possibly the lower end of Sherwood Creek.

Currently the native fish species in the Colville River include rainbow trout, largescale sucker, sculpin, redside shiner, and speckled dace. Non-native fish species in the Colville River include brook trout, brown trout, largemouth bass, pumpkinseed, yellow perch, brown bullhead, tench, and black crappie. Westslope cutthroat trout are located in two tributaries of the Colville River. Early stocking of salmonids in the Colville River above Meyers Falls and its tributaries begin in 1933 and 1934 with the stocking of brook trout, rainbow trout, brown trout, and cutthroat trout. Steelhead was stocked in the Colville River in 1933 and 1935. The fishery has degraded in the watershed as habitat quality has degraded. Brook trout which does better in degraded habitats has become the dominant fish species. Competition and degraded habitats has eliminated the cutthroat and bull trout fishery. The rainbow trout fishery is present in very small numbers. Cutthroat trout cannot compete with brook trout. Instead they move into the steep tributaries where the brook trout do not do well. In this analysis area, some tributaries have subterranean flow blockages. Bull trout hybridize with brook trout, but these hybrids do not reproduce. Degraded habitat cannot support the fish for the length of time needed to produce a mature bull trout.

Cottonwood Creek

On reaches below NFS Lands, the stream is generally degraded from logging, grazing, and roading. The stream has widened and the banks are eroding. No fish surveys have been done on private lands, but it can be assumed that fish in upper Cottonwood Creek have had access to this area. Because of the degradation in habitat brook trout are probably the dominant fish species. In the tributaries to Cottonwood Creek on NFS Lands above Woodward and Betts Meadows, the channels are characterized by bar formations behind debris jams that create multiple channels across the bars. The riparian area has cedars and forbs. These areas have had very little management and are close to reference condition. Because of the subterranean nature of these channels, there are fish only in the channels up to the first subterranean flow barrier. Because these streams carry high amounts of gravels, they provide excellent seasonal spawning habitat. These channels are moving high amounts of bedload.

Sherwood Creek

The major channel-defining event in Sherwood Creek was the Horseshoe Lake outbreak in 1974 (see Section 3.2). This event destroyed downstream fish habitat. Effects from the floods can still be seen. Currently the fish distribution on non-NFS Lands is unknown. There is probably seasonal use from trout for spawning habitat near the confluence with the Colville River. Fish were not found in surveys done in 1997 on NFS Lands.

Thomason Creek

Thomason Creek was analyzed in the Chewelah Creek Watershed Management Plan in December of 1993. This Plan noted that "Thomason Creek flows through forested, agricultural, and rural residential areas before flowing through a sparsely developed portion of the city. It flows adjacent to Flowery Trail Road for a portion of its length. This road carries much traffic to the 49 Degrees North ski area in the winter and is well maintained by plowing and sanding. The spray of snow and sand thrown up by the plowing operations has the potential of hitting the creek in limited areas. Thomason creek flows through a sod farm prior to entering the Colville River." The channels on NFS Lands are stable channels with moss covered undercut banks. Tree roots stabilize the banks. Woody debris form structure in the way of pools and debris jams. However, the creek here is too small to support a year round fishery, but could support seasonal spawning. There is a fish blockage at the culvert near the junction of the Cottonwood Creek Road and the Flowery Trail Road.

Other Riparian Habitat

The availability of site resources differentiates growing conditions in riparian areas from upland-forested areas. Unlike upland areas, water and nutrients are available throughout the growing season in most riparian areas. In response to these conditions, riparian vegetation increases in species diversity and structural diversity. It is this diversity in vegetation that differentiates riparian areas from the background forest matrix.

Species diversity and vegetation structural diversity increases habitat diversity in riparian corridors. Increased foraging opportunities, denning and nesting opportunities, and travel opportunities provided by riparian corridors benefit a wide range of species, including: beaver, great blue heron, waterfowl, amphibians, neotropical migratory birds, and others. Heron, waterfowl and amphibians favor lower gradient riparian areas, where beaver influence habitat and provide ponds. Neotropical birds favor the foraging opportunities provided by diverse riparian vegetation and vegetation structure during summer nesting and spring and fall migration. Intact corridors provide biodiversity protection across the landscape by providing habitat for rare and endangered species, and wide-ranging species and by providing dispersal routes for recolonization following local extinction.

Beaver are present in the analysis area. However, habitat conversion, forage loss, and trapping and eradication have all contributed to the decline of beaver compared to reference conditions. A corresponding decline in the species that use habitats created by beaver has occurred.

The quality of riparian corridor travel habitat for species moving from the Colville River Valley into upland habitats has deteriorated from reference conditions. Roads, pastures and logging, regularly interrupt the continuity of riparian vegetation between the valley floor and upland stream reaches.

Section 3.5 – Human Uses

What was the major use by indigenous people during reference conditions? What are the current conditions and trends of the prevalent human uses in the watershed?

Indigenous People

Indigenous people's culture and spirituality was linked to their environment through ceremonies, customs and social responsibility. How they managed their environment was dependent on these multidimensional connections.

The oral history of indigenous people indicates the area lying between the Colville River valley and the Calispell Divide was not occupied when Kalispel peoples looking for a place to settle first viewed it. This area has also been identified as the northern part of the range of the Spokane Indians, and the territory of the Chewelah Indians. All of these groups were part of the Plateau cultural tradition and the Salishan language grouping. As such, their resource based economy included a seasonal round of harvesting and trading for the various materials and foodstuffs required for life in the Plateau culture. A principle reason for traveling through the analysis area would have been to access the fishery at Kettle Falls where salmon was harvested and dried. The river valleys and lowland areas were generally used to gather camas, one of the very important staples of the Plateau diet, as well as waterfowl and waterfowl eggs. Upland areas were generally used to gather a variety of berries (mostly huckleberry), and for hunting game.

Peeled cedar trees near the Chewelah Trail indicate indigenous people used parts of the analysis area for gathering huckleberries. These small tree scars indicate the construction of small gathering baskets or platters or serving vessels. No other substantial Native American sites have been identified within the project area. We can assume however, that parts of the project area were used as short-term habitation sites and that there were trails passing through the area.

The only practice that would have significantly affected the ecosystem within the planning area was the use of fire to enhance resource habitat. There is ethnographic evidence of Native Americans setting fires to enhance habitat for huckleberries and forage for deer in the period around the 1850's. There is no data available indicating how early this practice may have been used or in what specific areas.

Other People

Today, 5.8% of Stevens County's 39,000 people are Native American. People of European decent and others comprise the remaining 94.2%. Fur-trappers and miners led the way for the in-migration of Europeans and others in the early to mid-1800s. Homestead settlement between 1890 and 1930 brought Stevens County's population to more than 18,000. This influx initiated the transition from reference landscape conditions to current conditions, when prospects for mining, timber, livestock grazing and crops lured people into the analysis area.

Today, these subsistence activities continue, however as leisure time increases so does the use of the area for recreation. Auto-touring, firewood gathering, berry picking, snowmobiling, cross-country-skiing, bicycling, hiking, camping, off-road vehicle riding, horseback riding, and hunting make up most recreation pursuits. Other human-uses in the area include domestic water use, scenery and solitude.

Timber harvest on NFS Lands has been limited to the Thomason and Woodward drainages. The Betts, Wessendorf and Sherwood drainages have not incurred any logging activity on Forest Service land. Logging has occurred within all watersheds on non-NFS Lands. Forest Service timber sale contracts typically limit ground-based (tractor) logging systems to slopes of 35% or less, with cable-based systems specified on slopes greater than 35%. Logging practices on non-NFS Lands use ground-based systems without slope limitations. Silvicultural prescriptions on NFS cutting units have included a wide range of prescriptions including clear cutting, broadcast burning, and artificial regeneration (planting). Logging prescriptions on non-NFS Lands has usually been less intensive than clear cutting with 50-70% of the basal area removed at each entry. One NFS timber sale is currently active on Eagle Mountain. The cutting units for this sale, within the Quartzite analysis area, are located on the south side of Eagle Mountain. Shelterwood harvests are prescribed for these stands as well as the use of ground-based logging systems. There are approximately 140 miles of roads within the analysis area. The highest road densities are located on non-NFS Lands at the lower elevations.

Most human-uses are compatible however some compete for area resources, and conflicts between users exist. Northern Stevens County is the home of several sawmill operations, and support for the timber industry is strong and relatively unopposed by any locally organized environmental groups. Two environmental groups have organized in neighboring counties, one of which opposes any logging on NFS Lands. Both of these groups focus their efforts on preserving unroaded areas. The Betts Meadows Wetland Preserve (see the subsection titled Wetlands in Section 3.2-Hydrology) wants to preserve the drainage above Betts Meadows. Chewelah is less timber dependent than northern Stevens County communities because of its distance from large sawmills and because its proximity to Spokane has allowed it to attract retirees and others to its scenery, recreation, and medical services. Many area residents however, commute to sawmills for work, or depend on timber felling, skidding and hauling jobs.

Chapter
4

Synthesis and Interpretation

Synthesis: The combining of separate elements or substances to form a coherent whole.

Interpretation: The explanation of conditions.

This chapter compares the current and reference conditions of the five broad ecosystem elements discussed in Chapter 3, and explains significant differences, their causes and their effects on ecosystem resilience.

Section 4.1 - Erosion Processes

What are the natural and human causes of change between reference and current erosion processes? What are the influences and relationships between erosion processes and other ecosystem processes? What role does riparian vegetation play in erosion processes and sediment transport and deposition processes?

Geology

Three situations of concern were identified for mass wasting and slope stability: steep talus slopes; the Chewelah Mountain thrust fault; and glacial till and outwash deposits. Mass wasting in the form of landslides can be expected almost exclusively on steep slopes within glacial sediments. These events, while of localized concern, are not significant at the watershed scale. Low stream densities and permeable soils within the watershed indicate that landslide sediment delivery rates to streams are limited.

The greatest potential impact from mass wasting is to road resources. Most roads located on glacial deposits have avoided steep slopes. Vegetation has stabilized cut and fill slopes and location and construction specifications have reduced mass wasting potential. However, seepage erosion at the base of a slope or roadcut can cause over-steepening with subsequent slumps and slides.

Soils

The vegetative cover across the majority of the analysis area has flourished in the absence of fire. This has maintained current surface soil erosion near reference levels. However, fire suppression and the subsequent fuel build up has increased the risk of catastrophic stand replacement fires, which if they occurred, would increase surface soil erosion. Unlike frequent low intensity fire, high intensity fire can remove the protective duff layer and leave soil exposed to weathering. Steep slopes would aggravate the situation, and increase the potential for sediment delivery to streams.

The primary source of sediment entering stream channels is from natural background levels. Stream bank erosion occurs where obstructions such as woody debris divert flows against banks and causes lateral shifting and sedimentation. The greatest potential for sediment delivery occurs in the smaller perennial and larger intermittent streams located on glacial alluvium. The channels of these streams are relatively stable, but the peak flows they convey are capable of eroding banks and beds. The magnitude of these events occurs on a small scale and is not likely to change dominant channel characteristics or processes. Larger perennial streams occupy channels formed during glacial periods of higher flows. Current peak flows in these channels do not reach the magnitudes that originally formed them and are consequently quite stable. The small intermittent and ephemeral streams carry surface water only during spring runoff, and even then, the magnitude of flow appears to be small and incapable of providing significant erosion potential or sediment delivery.

The second most important source of sediment in these watersheds is from roads. There are numerous roads within the analysis area which cross and/or are located adjacent to streams. The potential for erosion and sediment delivery to these streams is directly proportional to the distance between the roads and the streams. Roads located within 200-300 feet of streams may serve as a direct supply of sediment from their travel surfaces, as well as their cutbanks, fillslopes, and ditches. The responsibility of constructing and maintaining the road system within this analysis area lies with several different agencies as well as private landowners. At present there is little effort to coordinate this process. The Flowery Trail Granodiorite is a relatively non-resistant and easily weatherable formation, which has the potential to increase sediment loads in streams.

Section 4.2 - Hydrology

What are the natural and human causes of change between reference and current hydrologic conditions; stream channel conditions; and water quality? What are the influences and relationships between hydrologic processes and other ecosystem processes? How does riparian vegetation affect stream channel types?

Stream Channel

The streams and associated riparian systems in the lower portions of the analysis area are still reacting to the influences of logging, agricultural/grazing practices and ongoing residential development. However, the riparian zones in the upper portions of these subwatersheds remain intact and relatively unaffected by past management practices. As a result, riparian areas on National Forest System (NFS) Lands are functioning properly.

Peak flows within the analysis area are moderated by infiltration and percolation on slopes and in glacial fill. These areas buffer watershed runoff and moderate peak flows. Because of this, the most important channel stability factor is sedimentation. Direct sediment impacts to channels can occur through disturbance of riparian vegetation, road construction and maintenance, and large high intensity fire.

Livestock grazing on non-NFS Lands has deteriorated some riparian areas by accelerating bank erosion rates and altering channel morphology. In addition, some of these riparian areas have been drained and converted to agricultural cropland. Logging and road construction activities have also degraded these riparian zones by extending drainage channels and increasing the potential for sediment delivery through these new channels. These activities on lower elevation non-NFS Lands has decreased or eliminated the benefits that riparian vegetation provides (shading, sediment traps during over-bank flows on the floodplains, and the influence of roots on soil movement and bank stability).

Wetlands

Wetlands are often used to reflect of the overall health of a watershed because of the diversity and moderating influences associated with them. These areas are usually among the most sensitive landscape features within a watershed, and also the first to show damage. While they cover only a small percentage of the total analysis area, they nevertheless provide a disproportionate amount of public benefit in the form of wildlife habitat, recreation, clean water, and aquifer re-charge. Many low elevation wetlands have been converted for other land uses. Consequently, the moderating influence on peak flows and sedimentation they provided during reference conditions is absent. Management of the Betts Meadows Wetland Preserve, on the other hand, is moving the area toward these desirable reference conditions.

Water Quality

Too little is known of water quality conditions across the analysis area to compare them to reference conditions. However, a few areas of local concern are known. The fecal coliform situation downstream of Betts and Woodward meadows seems to be seasonal, and associated with beaver. Two other areas of concern were mentioned in the 1993 Chewelah Creek Watershed Management Plan. The first of which is Thomason Creek where water quality may be compromised by winter road maintenance on the Flowery Trail Road. Traction sand and salt thrown below the road during snow plowing may be entering the creek. Also, this plan noted that dissolved oxygen levels may be too low near the mouth of Thomason Creek where high nitrate and phosphorous from agriculture are stimulating aquatic plant growth.

Aside from these areas of local concern, general water quality is unknown. Water quality data from waters across the analysis area is lacking. To understand the current condition and trends, a more complete data set is needed.

Section 4.3 - Vegetation

What are the natural and human causes of change between reference and current vegetative conditions? What are the influences and relationships between vegetation patches, corridors and matrix and other ecosystem processes? How have upland structural conditions changed from reference conditions? How have changes in species composition, forest density and forest structure changed the resiliency of the landscape to fires, insects and diseases? How has fire suppression affected the character and arrangement of upland stands?

Fire suppression, logging, roads, and land use conversions have affected major change to the background forest matrix and the distribution of corridors and patches across this matrix. Upland forests, riparian vegetation, and other vegetation have all been affected by these changes.

Upland Forests

Natural processes (fire, weather) controlled the forest matrix, including the structure, composition, and density of forests, until the early 1900's. Since then, suppression of fire has all but eliminated the influence of this reference disturbance. With the lack of reference fire activity over the past seventy to ninety years, the successional forest sequence that leads toward climax species has proceeded unchecked within the un-managed portions of the analysis area. With this change comes an increase in fuels, an increase in insects and disease, a loss of shade-intolerant species, and an increase in shade-tolerant species. The current forest matrix on un-managed lands, reflects a trend away from the early to mid successional stages associated with reference disturbances, toward mid and late seral stages. Where logging or land use conversions have occurred most multi-stratum large tree patches and single-stratum large tree patches have been replaced by a more uniform matrix of single-stratum small trees, or by un-forested patches.

Graphs displayed in Section 3.3 illustrate the disparity between reference and current structural stage conditions across the four biophysical environment settings. BPE 2 which occupies 80% of the analysis and BPE 4 (11%) are the most problematic because of the significant deficit of single-stratum large tree patches and because of the *distribution* of multi-stratum large tree patches. Since both BPEs depend on relatively frequent fires to maintain vegetative composition and structure, fire suppression has affected them the most. In addition, because they occupy lower elevations they are also affected the most by logging, and land use conversion.

The general vegetation trends are for increasing risk of insect attacks in overstocked, multi-storied stands; increasing risk of severe fires; continued loss of seral species; and a decreasing ability to grow large trees. The patch-corridor-matrix analysis of forest structural stages shows a decrease in patch definition and a corresponding increase in matrix uniformity in both unmanaged less accessible areas and in more accessible logged areas. The potential for large patches resulting from high intensity fires is highest in unmanaged areas.

Riparian Vegetation

Changes in riparian vegetation are, for the most part, limited to areas where logging or land use conversions have occurred. Subtle changes have occurred in less accessible unmanaged areas where both dead and live fuels have slightly increased however, these changes are not significant. The multi-stratum large tree forests found in these areas are close to reference conditions. In contrast to this, most large tree stands located within the low elevation more accessible riparian corridors have been removed over the past 70 years. High value timber and agricultural suitability provoked most of this vegetation transformation.

Riparian protection standards are now in place on most forested lands within the analysis area, and trends indicate that if these standards are met, riparian vegetation conditions in forested areas will move toward reference conditions. Riparian vegetation conditions on non-forested pastureland or fields however, remain significantly altered and human use patterns indicate conditions will not change soon.

Other Vegetation

As described in Section 3.3, the analysis area has undergone extensive changes in type and cover of vegetation. Wetland conversions, loss of vegetation, and soil disturbance have occurred as a result of natural and human activities.

Some activities have created dense stands of timber; others have created openings or corridors. It is these openings or corridors that are presently or are most likely to become infested with noxious weeds. Noxious weed treatment is expanding on NFS Lands, with plans in the near future to treat weeds within the analysis area. These treatments will reduce the success of invading noxious weeds and reduce the spread of existing populations. In addition noxious weed awareness has increased for all landowners and prevention strategies are being integrated into most land use activities. However, the invasion, establishment, and spread of noxious weeds will be a continuing trend. Human activities will continue creating the conditions and providing the vectors for noxious weeds to move into and throughout the analysis area. Natural forces (including wildlife) will also play a role in this. Current efforts at revegetating disturbed sites will delay the trend, but will not reverse it in areas where noxious weeds are already established.

Like other situations in the analysis area, the current condition of sensitive plants is the result of fire suppression and riparian and wetland conversion. Habitat for species that evolved with frequent fire has diminished. Sensitive plants that occupied open stands of Ponderosa pine have declined. The function of fire in the ecosystem is gaining understanding, however its use as a land management tool is still viewed with skepticism and trends indicate that habitat conditions for these species will remain static. Habitat conditions for sensitive plants that evolved in riparian and wetland areas remain static on NFS Lands. The conversion of wetlands in other areas has caused local extinction and like riparian vegetation, human use patterns indicate conditions will not change soon.

Section 4.4 – Species and Habitats

What are the natural and human causes of change between reference and current species distribution and habitat quality for species of concern? What are the influences and relationships of species and their habitats with other ecosystem processes? How have changes in riparian condition affected dependent species? How do changes in species composition, forest density and forest structure affect wildlife habitat? Has habitat diversity changed relative to reference conditions? How has fire suppression affected species dependent on old forest-single story structure? How have changes in species composition, forest density and forest structure affected species dependent on old forest mult-story structure?

As noted in Section 3.4, a precept of ecosystem analysis is that native species have evolved with reference disturbance regimes and the landscape patterns of habitats resulting from those regimes. Native species diversity and associated ecosystem functions and processes therefore are inextricably linked to the spatial patterns of patches, corridors and matrix across the landscape.

Upland Forest Habitats

Patches with multi-stratum structure and large trees (SS6) were identified as a habitat of concern for a variety of species. The patch-corridor-matrix analysis of forest structural stages shows that the quantity of this habitat type is within reference ranges, but that the location of many patches is outside reference strongholds. Many lower elevation areas and other areas on north facing slopes that serve as strongholds for these patches are currently deficient of this habitat. In addition, the longevity of those SS6 patches currently located on south and west facing slopes is threatened by their multi-stratum character, site conditions and reference disturbance events.

While the current quantity of SS6 habitat is within the range of reference conditions, it is generally segregated into the less accessible NFS Lands and located on sites where other structural stages were more common. These vegetation conditions and current land use trends indicate that the quantity of this habitat is threatened on NFS Lands and that low elevation recruitment is likely to increase only in narrow riparian areas.

The current condition of patches of habitat with single-stratum structure and large trees (SS7) is juxtaposed with those SS6 patches currently located on south and west facing slopes. Reference fire events for these areas that now have SS6 patches, historically maintained SS7 patches and suppression of these reference events has allowed SS6 patches to displace SS7 patches. Native species that evolved with reference SS7 patches have also been displaced in these and most other areas where reference quantities of SS7 have sharply declined. Habitat trends for native species dependent on SS7 is much like that as for species dependent on SS6, however, recruitment is unlikely outside NFS land.

Seclusion habitat for the large-home-range species of concern has diminished. Data for key home range components outside the analysis area is lacking. Consequently, the importance of the block of seclusion habitat located within the analysis area is unknown. Land use in watersheds adjacent to the analysis area however, show that habitat fragmentation has occurred and that few areas of seclusion habitat exist. As noted in Section 3.4, the few grizzly bear and gray wolf sightings documented over the past 20 years infers that the area may only be used as transitory habitat between other preferred home ranges, or that the habitat is not used. Human use trends in and adjacent to the area do not bode well for large-home-range species that are dependent on seclusion habitat. No habitat recovery efforts exist outside of State and NFS Lands. However, a 1993 USFS Grizzly Bear Recovery Plan designated the Selkirk Recovery Zone to improve habitat in this area that is located 20 miles east of the analysis area, across the Pend Oreille River.

Riparian Habitats

In-stream fish habitat degradation in the analysis area is aggravated by degraded conditions in the Colville River. Reference fish populations expanded into the analysis area from the Colville River, which served as a refuge when upland habitat conditions deteriorated. However, channelization and the stocking of non-native fish in the Colville River has increased the competition for limited habitat to the point where native species have severely declined or been eliminated. As a result, this reference refuge can no longer supply native fish populations for re-colonization in the analysis area. Similar simplification of in-stream habitat has occurred in the lowest reaches of Thomason, Sherwood and Cottonwood Creeks, where channelization and riparian vegetation removal has occurred. Upland and wet land in-stream habitat has been degraded by the change in riparian vegetation.

The viability of trout species can be assessed by the distribution and quality of their habitat. Stream channel conditions in the analysis area have been degraded by logging and roading and land use conversion activities. These channels are highly dependent on woody debris for channel structure. The switch from timbered riparian habitat to pasture land has negatively affected bank stability. This has negatively impacted the native fisheries. Since no cutthroat and bull trout have been found within this area, it is theorized that habitat conditions have changed to the degree that these populations are no longer present at viable levels. A small rainbow trout population is holding on and the non-native fisheries are strong. Brook trout have successfully out-competed native trouts in the current degraded habitat.

The non-fish bearing upper stream reaches in the analysis area are important sources of gravel and cool water. Most of these are located on NFS Lands where riparian vegetation is near reference condition. Riparian protection standards are designed to maintain these conditions.

The quality of other riparian habitat has also declined. Low-mid elevation human activities have removed reference riparian vegetation, eliminated wetlands and severed riparian corridors between the Colville River Valley and upland streams. As a result, the habitat benefits associated with species diversity and vegetation structural diversity have declined and dependent species have experienced local extinction, or have migrated to micro-sites within the analysis area. Increased beaver activity and wetland restoration like that being done by the Betts Meadows Wetland Preserve will improve conditions for dependent species, on a small scale.

Section 4.5 – Human Uses

What are the causes of change between reference and current human uses? What are the influences and relationships between human uses and other ecosystem processes?

Humans have become the dominant species in the analysis area. The current arrangement of patches, corridors and background forest matrix on the landscape reflects this status and trends indicate human interests and needs will continue to dominate ecosystem components and their relationships.

Human population densities in and around the analysis area have increased in part because of the ability of the region to provide income through resource extraction. Timber and minerals from the analysis area have contributed to this, and while dependence has declined, area residents still rely on resource extraction for income. Resource protection strategies like fire suppression resulted from this relationship and were instituted in part as a way to maintain an inventory of potential income.

Much of the disparity between reference and current conditions in the ecosystem today is a result of human dependence on area resources. The suppression of fire across the analysis area has caused the most disparity and the resulting changes in the structure of vegetation, and the distribution of patches have had a ripple effect on many other ecosystem components. Plant and animal species that evolved with reference disturbance events and vegetation have been displaced or have seen severe changes in habitat. Competition for site resources has increased and consequently forest health has declined as opportunistic insects and pathogens replace fire as the dominant disturbance event.

Since 1900, timber, livestock and agriculture have provided income on lower elevation non-NFS Lands, including the adjacent fertile Colville River Valley. The effects of these activities on reference riparian corridors have been dramatic. Much of the diverse vegetation associated with these corridors has been converted to younger, simpler forests or removed for agricultural purposes. With the resulting loss of in-stream large woody debris along the mid to lower reaches of Thomason, Sherwood and Cottonwood Creeks, comes a reduction in quality of fish habitat. The conduit for wildlife species moving to and from upland and valley bottom habitat does not exist in some areas and is interrupted in many others.

For a variety of reasons, humans needed roads. These efficient human travel corridors made extraction affordable and allowed us to access distant areas at a profit. Some unknown costs however, were not recognized until later. As we increased our access, we unknowingly created habitat for many opportunistic noxious weeds that have moved beyond roads to displace native species in a variety of habitats. Roads also introduced change to reference wildlife habitat. The connectivity of wildlife corridors has been compromised in many places where roads cross riparian areas. In addition, as access into the analysis area increased, roads penetrated reference seclusion habitat for large-home-range vertebrates and today much of this habitat is compromised.

Humans have benefited from the use of the analysis area, and while ecosystem integrity has decreased, ecosystem processes continue to function. A variety of opportunities still exist to improve productivity, biodiversity, water, and soil characteristics.

Chapter
5

Recommendations

This final chapter displays recommendations (restoration, maintenance, protection, alteration) that would improve ecosystem resilience and ecological integrity. Recommendations are focused on the two issues identified in Chapter 2 (Stream Corridors and Wetlands; and Upland Vegetation) and are specific to the ecosystem components and processes related to these issues.

Recommendations are based on the following:

- A sustainable environment is an area in which ecological integrity and human needs are concurrently maintained over generations.
- Ecological integrity is the combination of near-reference levels of productivity, biodiversity, water, and soil characteristics.
- Ecosystem resilience is the ability of an ecological system to maintain its functions in the face of change or disturbance.
- Human activities can move the area toward a sustainable condition.

In addition, the analysis team recognizes that people and their opinions are important, and that recommendations that are likely to be controversial will require additional analysis and public involvement. **Recommendations only pertain to National Forest System lands.** These recommendations serve as a starting point for cooperation with other landowners or agencies, if the opportunity arises.

The listing of these recommendations does not imply that they will or must be implemented, or that the ecosystem will cease to function if they are not implemented. They are only recommendations to move toward a sustainable environment.

Section 5.1 – Vegetation Management Recommendations

1) Move the landscape vegetation toward the reference condition, based on the biophysical setting. Develop forest matrix, patches and corridors that are consistent with reference disturbance regimes. This may be accomplished by commercial timber sales, non-commercial thinning, prescribed fire, or all three, or by certain natural events such as fire, wind, etc.

- For the Warm Dry Douglas-fir/shrub biophysical environment (BPE2): increase the amount of early structural stages (SS1-3); decrease the amount of middle structural stages (SS4 & 5); decrease or maintain the amount of multi-stratum with large trees (SS6); and increase the amount of single-stratum with large trees (SS7).

- For the Cool Mesic Douglas-fir grand fir/forb-shrub biophysical environment (BPE4): increase or maintain the amount of early structural stages (SS1-3); decrease the amount of middle structural stages (SS4 & 5); maintain the amount of multi-stratum with large trees (SS6); and increase the amount of single-stratum with large trees (SS7).

- For the Cool Mesic cedar-hemlock/forb-shrub biophysical environment (BPE5): maintain the amount of early structural stages (SS1-3); decrease the amount of middle structural stages (SS4 & 5); and increase the amount of multi-stratum with large trees (SS6).

- For the Cold Mesic subalpine fir/forb-shrub biophysical environment (BPE8): increase the amount of early structural stages (SS1-3); decrease the amount of middle structural stages (SS4 & 5); and maintain the amount of multi-stratum with large trees (SS6).

2) Break up the continuity and homogeneity of stand structures and compositions created by fire suppression. Decrease the risk of high intensity fires and their detrimental impacts to water quality and soil productivity. Maintain open forest habitat and rejuvenation of oceanspray, especially in areas preferred by fire dependent sensitive plant populations. Enhance ungulate winter range forage areas by stimulating browse. Increase Lynx Forage habitat. (Habitat should contain dense stands of young lodgepole pine suitable for snowshoe hare).

- Reintroduce fire in those areas adapted to low and moderate fire regimes, and on the landscape as a whole.

- Use reference disturbance regimes to establish a schedule of maintenance underburns to reduce fuel loading and the potential for destructive, stand-replacing fires.

3) Prevent the establishment of new noxious weed species and reverse the trend of expansion of infected sites.

- Immediately eradicate any newly discovered noxious weed species or populations.

- Design land management activities that reduce soil disturbance and loss of vegetation.

  - Include mitigation to prevent or reduce the introduction or spread of noxious weeds, consider the cleaning of equipment prior to entering a site; and re-vegetation of all disturbed soil.

  - Use seed that is noxious weed free. Use seed that will best meet the objectives of the site while inhibiting the establishment of noxious weeds. Use native seed if available, if economical and if competitive with the noxious weeds in the area. Use seed that will eventually allow for the establishment of native vegetation where appropriate.

- Provide opportunities to inform forest users about noxious weeds, and noxious weed identification, and prevention strategies for noxious weeds.

  - Incorporate forest users into activities that manage populations of existing noxious weeds.

   - Develop partnerships with adjacent landowners and other agencies to jointly manage noxious weeds.

   - Showcase noxious weed prevention projects to help inform the public of the effectiveness and benefits of preventing noxious weeds.

4) To determine sensitive plant population trends, monitor existing sensitive plant populations and conduct additional surveys for sensitive species.

5) Maintain and develop habitat for plants and animals dependent on SS6. Within reference SS6 stronghold areas (see the map in Chapter 3, Section 3.4), protect existing SS6 and reduce stocking to develop large diameter trees where SS4 and SS5 occurs.

- Develop timber sale areas that avoid existing SS6 in stronghold areas.

- Establish fire management strategies that protect existing SS6 in stronghold areas.

- Develop commercial and non-commercial forest thinning or prescribed fire to reduce stocking within SS4 and SS5 in stronghold areas.

6) Maintain and develop habitat for plants and animals dependent on SS7. Within BPE2 and BPE4, convert existing SS6 areas to SS7 on south and west aspects below 4600 feet elevation. Where SS4 and SS5 occurs in these areas, reduce stocking to develop large diameter ponderosa pine and Douglas-fir trees.

- Protect large ponderosa snags for white-headed woodpecker nest and roost sites and for foraging.

7) Within the Warm Dry Douglas-fir/shrub biophysical environment (BPE2): remove shade-tolerant species to improve the quality and availability of forage.

- Use reference patch/matrix distributions to increase the effectiveness of deer and elk forage patches and cover.

Section 5.2 Road Management Recommendations

1) Road densities were identified as a concern for water quality, noxious weeds, and for some wildlife species. However, people drive roads to gather firewood, gather huckleberries, hunt, and for recreation. The National Forest needs roads to manage wildfires, and to manage vegetation.

- Evaluate the entire road system. Determine which roads are necessary for long-term land management and recreation. Identify roads to be kept open, closed seasonally, closed except for administrative use, closed to everyone year-round, or obliterated.

- Consider closing or obliterating:

   - roads that are sediment sources or that disrupt hydrologic function or that closely parallel riparian areas.

  - roads in Canada lynx habitat.
  - roads in deer and elk winter range (seasonal closure may be sufficient).
  - roads that add to the spread of noxious weeds.
  - roads that effect the quantity of snags in SS6 and SS7 areas.

- Close or obliterate roads effectively and in a manner that minimizes sedimentation and noxious weeds.
- Balance the impacts to new road construction with the benefits of road dependent projects.

2) If a road is to be closed after use, design the road (including reconstruction) to facilitate the eventual closure. Where roads to be closed intersect with open roads, design the intersection so that the closed road is not as noticeable. Design the beginning of the road to facilitate an effective closure.

3) Modify current road maintenance practices to:

- Disperse roadbed drainage at regular intervals and armor the outlets.
- Avoid blading the roadbed vegetation so it can protect the roadbed from erosion and filter eroding particles.
- Stabilize rather than undercut the toe of cutslopes that are sloughing onto the roadway.
- Do not sidecast waste material where it can reach a riparian area (this does not include snow).

4) Encourage coordination between the variety of entities responsible for road construction and maintenance. Share information and techniques that improve road conditions.

5) Manage road construction and maintenance to minimize noxious weeds.

- Inventory and monitor roads, gravel pits and storage yards for noxious weeds.
- Seed areas disturbed through grading, pulling ditches, installing culverts, or constructing kelly humps, etc. Use seed mixes that are noxious weed free.
- Develop a system for road maintenance crews to report new or expanding noxious weed infestations.
- Immediately revegetate bare soil created from road construction or reconstruction, including both system and temporary roads.

Section 5.4 Wildlife Habitat Management Recommendations

1) In the short term, follow the Colville National Forest Land and Management Plan's management requirements for species dependent on old growth forest habitat (SS6). Where possible, designate habitat units within reference SS6 strongholds (see the map in Chapter 3, Section 3.4), or on sites capable of supporting these habitat types. Within BPE2 and BPE4, avoid designating habitat units that include existing SS4, SS5 or SS6 on south and west aspects below 4600 feet elevation.

- Develop long term management strategies for species dependent on old growth forest habitat (SS6). Strategies should mimic the dynamic landscape patterns of patches and habitats resulting from reference disturbance regimes.

2) Develop SS7 habitat within BPE2 and BPE4. Groom SS4, SS5 and SS6 areas on south and west aspects below 4600 feet elevation to hasten the development of SS7 conditions. Simplify existing SS6 areas on south and west aspects below 4600 feet elevation to enhance and protect the large tree cohort.

- Use fire to maintain or enhance desired structure where appropriate.

- Use commercial and non-commercial thinning to hasten the development of SS7 conditions.

3) Discourage recreation activities that reduce Lynx habitat quality, ungulate winter range and seclusion habitat.

4) Coordinate with other land owners to maintain fish passage from the Colville River to the tributaries in the analysis area.

Section 5.5 Stream and Wetland Management Recommendations

1) Design vegetation management activities within the Sherwood watershed that protect sensitive stream reaches located below Horseshoe Lake from high peak flow events.

2) Design projects that restore the proper functioning of wetland processes and improve aquatic habitat within Woodward Meadows.

- De-channelize the stream and encourage reference meanders.

- Introduce riparian species in those areas of the meadow, which have historically supported such vegetation.

- Encourage beaver to return by planting preferred vegetation and restoring drainage patterns.

- Increase the shading of stream banks and wetlands to reduce water temperatures, improve fish habitat, and meet state water quality standards.

- Eradicate reed-canary grass.

- Install nest structures or build islands to protect nesting waterfowl from predation.

- Consider establishing cooperative wetland interpretative programs, with the Betts Meadows Wetland Preserve.

3) A cooperative survey of streams and riparian conditions should be conducted on those lands located outside of NFS Lands, to improve our understanding of current conditions.

4) Acquire additional water quality samples from the Cottonwood Creek tributaries to isolate the source of fecal coliform bacteria and determine if state water quality standards are being violated.

- If problems persist, design appropriate restoration activities.

5) Coordinate with other land owners to maintain riparian buffers from the Colville River to the tributaries in the analysis area.